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HYDROCORALS OF THE NORTH PACIFIC OCEAN

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Hydrocorals comprise those coelenterates of the orders Stylasterina and Milleporina, which, belonging in the class Hydrozoa, are probably highly specialized offshoots of hydroid ancestors. As in the case of marine hydroids the sexual individuals are entirely different from the feeding polyps. In the Stylasterina, the only order represented in the north Pacific, the gonophore is developed in a cavity of the coenosteum, called the ampulla, which often causes a blisterlike convexity on the surface of the colony, or may be superficially invisible owing to its position below the surface. In all the north Pacific species, represented by adequate material, the ampullae are of two distinct sizes. The smaller have been arbitrarily called male ampullae without benefit of microscopic examination; while the larger, usually twice as broad as the male, have been called female. In some cases the latter are known to house ova or planula larvae. With possibly one exception, the two sorts do not occur on the same colony. In dealing with material that is usually desiccated and unfit for histological examination it would perhaps be preferable to employ such terms as major and minor ampullae instead of female and male. That so-called male ampullae are not undeveloped stages of the female is amply demonstrated by their frequently different form and crowded condition. In *Allopora polyorchis*, a typical case, there would not be sufficient space to allow the small ampullae to expand to the size of the major ampullae.

The region covered by this report includes all the water north of a line drawn from the southern boundary of the United States (lat. 32° 30′ N.) to the southern end of Sakhalin Island (lat. 46° N.). All tropical and subtropical species are therefore extralimital.

The material[1] upon which this paper is based is a part of the rich collection of Stylasterina in the United States National Museum, augmented by scattered specimens from other sources, chiefly the Hopkins Marine Station of Stanford University. The types of all the new forms are in the collection of the National Museum.

The following extralimital species have been figured: *Cryptohelia pudica* Milne Edwards and Haime, plate 64, figure 1; *Cryptohelia japonica* (Milne Edwards and Haime), plate 64, figures 2 to 4; *Cryptohelia gigantea*, new species, plate 64, figure 5; *Distichopora sulcata* Pourtalès, plate 74; *Distichopora gracilis* Dana, plate 75.

Systematics of the Stylasterina present difficulties peculiar to the group in addition to those apparently inherent in the Coelenterata. Material for the most part consists of the dried skeleton of the colony, frequently imperfect. There is a slight sexual dimorphism added to the pitfalls presented by variation due to environment and lineage. Even in alcoholic material the gastrozooids and dactylozooids are often invisible by retraction, while the contents of the ampullae have proved to be of no practical value in differentiating species. Finally, the structures available are all very small and must be studied and drawn under high magnification, illuminated by a beam of concentrated light. It scarcely needs pointing out that great care must be exercised in taking accurate measurements. Under these conditions the comparison of elements and evaluation of variations imposes a severe strain upon any but the strongest eyes. Such painstaking analysis is necessary before progress can be made in the natural history of this group. The papers of H. N. Moseley and Dr. Hjalmar Broch have set a standard of excellence that unfortunately only a few have tried seriously to equal. Much of the literature is vague and sketchy judged by modern standards and can not be relied upon in a critical study.

The north Pacific is far richer in indigenous species than the north Atlantic. *Stylaster gemmascens alaskanus* and *Allopora norvegica pacifica* are representative forms of two well-known Atlantic species.

[1] My thanks are due to the authorities of the U. S. National Museum for the privilege of studying its collections; to those of the Peabody Museum, New Haven, Conn., and the Museum of Comparative Zoology, Cambridge, Mass., for the loan of material for comparison; to Dr. Sixten Bock, of the Riksmuseum, Stockholm, for the loan of north Atlantic material and of literature; to Dr. Hjalmar Broch, of the Royal Frederick's University, Oslo, for the identification of Japanese and Okhotsk Sea material and for the loan of examples of several of his species; to Dr. T. Wayland Vaughan for material, chiefly *Distichopora;* to Dr. H. Hattori, Biological Laboratory, Imperial Palace, Tokyo, Japan, for the gift of a representative collection of Japanese Stylasterina; to Dr. Elisabeth Deichmann, Museum of Comparative Zoology, for aid in various ways; to Prof. G. E. MacGinitie for several photographs of specimens; and to E. F. Ricketts, of Monterey, Calif., for the types of *Allopora petrograpta.*

But the other Stylasters and Alloporas appear to have no close counterparts in the Atlantic with the exception of a race of the widely distributed *Stylaster eximius* reported by Dr. Broch from the Okhotsk Sea. It is certainly premature to speculate on the distribution of the species found in the Okhotsk Sea, a region that has hardly been scratched by the dredge. *Allopora boreopacifica* is common to the Sea of Japan and the Okhotsk Sea. *Allopora scabiosa* has a closely related form in Sagami Bay (Hattori collection), but *Allopora solida* is not very closely related to any known species. It will hardly be surprising if *A. stejnegeri* and *A. brochi* are eventually added to the Okhotsk fauna.

So far as the western coast of the United States is concerned only five species are present: *Allopora californica*, *A. venusta*, *A. verrilli*, *A. porphyra*, *Errinopora pourtalesii*. No true *Stylaster* has yet been found.

I have also examined material from the region of the Galapagos Islands, which is well represented in the National Museum. This fauna has nothing to do with that of the north Pacific. If it points anywhere it is to the West Indian region. *Cryptohelia* is the dominant genus.

As a parenthetic observation on the distribution of the Stylasterina, the only species known to inhabit the Hawaiian plateau is *Stylaster sanguineus*. Probably *Distichopora violacea* also occurs, although I can find no record. These are shallow-water tropical forms. Although I was in constant and close touch with all the detailed and carefully planned deep-water dredging done by the *Albatross* in 1902, I do not recall a single specimen of deep-water *Stylaster*, such as occurs in the East Indies, or of any other hydrocoral for that matter. The great depths surrounding the Hawaiian group appear to constitute an effective barrier, although the planulae of *Stylaster sanguineus* are probably transported in warm surface currents. If the last observation is not true, the only alternative is to conclude that *Stylaster sanguineus* reached the Hawaiian group when those islands were part of a land mass extensive enough to afford a shallow-water path from some Indo-Polynesian center of dispersal. If such were the case it seems likely that species characteristic of depths of from 100 to 800 fathoms, such as *Cryptohelia*, would also have traveled along a "lower road."

In table 1 are listed all the *Albatross* dredging stations in the north Pacific at which the species described in this report were taken, with all pertinent data for each station, and species taken at each station.

The Stylasterina naturally occur on a bottom that provides some solid objects permanent enough to afford attachment for the colony. Yet the nature of this is not always apparent from the data recorded, as for instance station 2852, "black sand" (*Allopora campyleca*); sta-

tion 4302, "blue mud" (*A. campyleca*). The bottom record for station 4777 reads "fine gravel", yet a small colony of *Allopora verrilli* and two of *Errinopora nanneca* (also three species of encrusting bryozoans) were growing on a very hard pebble 50 by 30 by 25 mm. Rocks, pebbles, and shells form the usual foundation whether or not there be mud, sand, or fine gravel accompanying. *Allopora campyleca* favors black sand or blue mud; while *Allopora boreopacifica* is found on pebbles in brown mud and fine black sand.

As regards temperature, the lowest is favored by *Allopora boreopacifica*, *A. norvegica pacifica*, and *Errinopora stylifera* at 29.8° to 32° F. Then there is a hiatus. From 37° (the probable temperature at station 3480) to 39° are found *Stylaster cancellatus*, *S. elassotomus*, *S. gemmascens alaskanus*, *Allopora campyleca* (and its subspecies *tylota* and *trachystoma*), *A. polyorchis*, *A. moseleyana* (and forma *leptostyla*), *A. stejnegeri*, *A. brochi*, *A. verrilli* (typical), *Cryptohelia trophostega*, *Errinopora nanneca*, *E. zarhyncha*, and *Distichopora borealis*. Between 41° and 44° is found *A. campyleca* not precisely typical nor yet well enough differentiated to show tangible characters. It is probable that *A. papillosa*, *A. verrilli*, and *A. petrograpta* occur here. Between 46° and 52° are found *A. campyleca paragea*, *A. venusta*, *A. californica*, *A. porphyra*, *Errinopora pourtalesii*, and at the lower limit *A. petrograpta*. *E. pourtalesii* ranges from the Strait of Georgia to south of Monterey Bay, and *A. californica* from the Farallone Islands to Lower California. Both species probably range into water warmer than 52°.

It is evident that station 3480 is a very favorable environment for hydrocorals, since there was dredged here a considerable bulk of material, comprising eight forms, some of which are massive. This station was in Amukta Pass, east of the Andreanof Islands of the Aleutian Chain, in 283 fathoms, rocky bottom with black sand. The Aleutian Islands form the crest of a very long, curved, mostly submarine mountain chain, which falls away to great depths on the south. It constitutes a partial barrier athwart Bering Sea, one of the sources of cold bottom water of the north Pacific. That bottom currents are present in the numerous passes of the Aleutian Chain is inevitable. Such water should be rich in oxygen and in planktonic organisms, or their dead remains.

The structure of the corallum of some Stylasters and Alloporas indicates that the species live where there is a gentle current predominantly in one direction. The peripheral branches are bent slightly toward the anterior face of the colony, which becomes slightly concave. Most of the gastrozooids are on the front and sides of branches, or on the sides only. Usually the back, presumably facing the current, is almost devoid of gastrozooids. This form of growth is also found in some species of *Cryptohelia*. The Alloporas of station 3480

evidently lived in a current but probably not a strong one; otherwise the bottom would be scoured free of sand.

This paper was submitted for publication prior to the receipt of Dr. Hjalmar Broch's "Untersuchungen an Stylasteriden" (1936). Through exchange of specimens I am fairly accurately informed concerning those of Dr. Broch's new species which should be included in

TABLE 1.—Albatross *dredging stations at which hydrocorals were obtained*

Station	Locality and Bearings	Depth	Nature of Bottom	Temperature	Species Taken
		Fathoms		°*F.*	
2852	Shumagin Islands, 55°15′ N., 159°37′ W.	58	Black sand	41.8	*Allopora campyleca.*
2858	Gulf of Alaska, 58°17′ N., 148°36′ W.	230	Blue mud, gravel	39.8	Do.
2873	Off Cape Flattery, 48°30′ N., 124°57′ W.	40	Rocks	47.8	*Allopora venusta.*
2874	do	27	Rocks and shells	50.3	Do.
2875	do	40	do	47.8	Do.
2888	Off Oregon, 43°58′ N., 124° 57′30″ W.	41	Coral and pebbles	47.6	Do.
3050	Off Oregon, 44°01′15″ N., 124°57′ W.	46	Coral, broken shells	46.1	Do.
3158	N. of Farallone Islands, Calif., 37°47′30″ N., 123° 10′40″ W.	29	Rocky	51.4	*Allopora venusta, A. californica, Errinopora pourtalesii.*
3159	N. of Farallone Islands, Calif., 37°47′20″ N., 123° 10′ W.	27	do		*Allopora californica, Errinopora pourtalesii.*
3480	Amukta Pass, Aleutian Islands, 52°06′ N., 171°45′ W.	283	Black sand, coral, rocky.		*Stylaster cancellatus, S. gemmascens alaskanus, Allopora campyleca, A. polyorchis, A. moseleyana leptostyla, Cryptohelia trophostega, Errinopora zarhyncha, Distichopora borealis.*
3599	Bering Sea, N. of Rat Islands, 52°05′ N., 177°40′ E.	55	Rocky, fine sand, shells.		*Allopora campyleca, Errinopora nanneca.*
4230	Behm Canal, Alaska	240–108	Rocky	42.4	*Allopora campyleca.*
4245	Kasaan Bay, Prince of Wales Island, SE. Alaska.	95–98	Dark-green mud, sand, shells, rocks.	48.9	*Allopora campyleca paragea.*
4302	Off Shakan, Summer Strait, SE. Alaska.	212–169	Blue mud	44.2	*Allopora campyleca.*
4777	Petrel Bank, Bering Sea, 52°11′ N., 179°49′ E.	52–43	Fine gravel (coarse pebbles).		*Allopora brochi, A. stejnegeri, A. verrilli, Errinopora nanneca.*
4781	Off Agattu Island, 52°14′30″ N., 174°13′ E.	482	Fine gray sand, pebbles.	38.6	*Stylaster elassotomus, Allopora campyleca tylota, A. moseleyana, Distichopora borealis.*
4784	Off East Cape, Attu Island, Aleutian Islands, 52°55′ 40″ N., 173°26′ E.	135	Coarse pebbles		*Allopora campyleca trachystoma.*
5016	Okhotsk Sea, off S. end of Sakhalin Island, 46°44′ N., 143°45′ E.	64	Brown mud, fine black sand, rocks.	29.8	*Allopora norvegica pacifica, A. boreopacifica, Errinopora stylifera.*
5017	Okhotsk Sea, 46°43′30″ N., 143°45′ E.	64	Brown mud, black sand, pebbles.		Do.

this report. Of *Allopora norvegica pacifica*, *A. boreopacifica*, and *Errinopora stylifera* I had already made illustrations. *A. scabiosa* and *A. solida* of the Okhotsk Sea were new to me, but it has not been deemed expedient to include figures of them at this late date since they have been fully treated in Dr. Broch's memoir.

GLOSSARY OF TERMS USED IN DESCRIPTIONS

Ampulla: The cavity in the coenosteum containing male or female gonophores or sexual members of colony. These often form blisterlike convexities on the surface.

Coenosteum: The hard calcareous substance that constitutes the skeleton of colony, in contradistinction to the animal tissue which forms it.

Corallum: The calcareous skeleton of the colony as a whole. (Hydrophytum of Hickson.)

Cyclosystem: The gastropore surrounded by a circle of dactylopores coordinated with it.

Dactylopore: The small pore into which the dactylozooid retracts.

Dactylostyle: Very tiny spicules along the wall of dactylopore.

Dactylotome: The shallow slits radiating from the margin of gastropore into which the dactylopores open.

Dactylozooid: The tentaclelike, mouthless member of the colony, armed with abundance of nettle cells, which accompanies the feeding individual or gastrozooid. (Pl. 70, fig. 2*a*.)

Flabellum, flabellate, flabelliform: Fan, fan-shaped, in reference to the form of the colony.

Gastropore: The central depression of a cyclosystem (or the larger pore when no cyclosystem is differentiated) into which the gastrozooid retracts.

Gastrostome: The mouth of the gastropore.

Gastrostyle: The upright spiculated projection at bottom of gastropore forming also a projection into the gastric cavity of the polyp.

Gastrostyle chamber: A very narrow space surrounding the gastrostyle and sometimes separated from the portion of gastropore above style by a cheval-de-frise of spicules.

Gastrozooid: The feeding polyp of the colony.

Gonophore: The sexual members of colony lodged in a cavity or ampulla. Male and female gonophores are on separate colonies.

Planula: The specialized gastrula larva that may sometimes be found in "mature" female ampullae. One of its peculiarities is the possession of an abundance of nettle cells in the ectoderm. (Moseley, 1879, pl. 42.)

Genus STYLASTER Gray

Stylaster Gray, Zool. Misc., 1831, p. 36 (type: *Madrepora rosea* Pallas, 1766).

Eustylaster Broch, Danish *Ingolf*-Expedition, vol. 5, pt. 5, p. 8, 1914 (type: *Madrepora gemmascens* Esper); Untersuchungen an Stylasteriden, pp. 9, 15, 1936.

Stylaster has been used in the traditional sense as a matter of convenience. I agree fully with Dr. Broch that there is no definite hiatus between *Stylaster* and *Allopora*. Admitting this, I feel that it is rather academic to reduce these time-honored groups to the status of subgenera and then to employ a trinomial designation for every

species as Dr. Broch has done. The inherent difficulty of allocating an annectant species to either *Allopora* or *Stylaster* is in no wise lessened when these groups are regarded as subgenera of an expanded *Stylaster*, although possibly one's sense of responsibility is a trifle lulled.

These remarks concern a point of view on a matter of usage. They are in no way intended as a criticism of Dr. Broch's truly epoch-making paper. It ranks with Moseley's classic as a standard work absolutely indispensable to future students.

I am, however, unable to agree with Dr. Broch in the matter of his new name *Eustylaster* for the subgenus *Stylaster*, sensu stricto. In the subdivision of a genus it seems to me to be axiomatic that the section that includes the original type species should retain the original generic designation.

STYLASTER ELASSOTOMUS, new species

PLATE 41, FIGURE 3; PLATE 42, FIGURES 1–1*c*; PLATE 49, FIGURE 1

Diagnosis.—Colony small, arborescent, not profuse, branching predominantly in one general plane; cyclosystems resembling those of *A. campyleca tylota* but with still shorter and very shallow dactylotomes; mouth of the dactylopore at extreme margin of the cyclosystem; dactylotome very short and shallow (pl. 42, fig. 1*b*). Type colony 60 mm high, 50 mm broad.

Description.—The colony is of the *Stylaster* type. There are no signs of coalescence of neighboring branches. The front of the colony is shown by plate 49, figure 1. The opposite side is devoid of cyclosystems, but there are a few male ampullae near the ends of the branches.

The cyclosystems are notable for the small size of the numerous dactylotomes (10 to 17) and the short distance they encroach vertically upon the gastropore wall. The vertical pores are relatively larger than in *A. tylota*, and the dactylostyle is usually conspicuous, although not always so much so as shown by the figure, which represents its maximum development. The gastropore is deep and normally curved; style slender, the style chamber differentiated by the presence of slender spicules protruding into its lumen in sharp contrast to the smooth walls of the pore above it. Diameter of cyclosystem 1 to 1.2 mm; depth of gastropore about 2 mm; gastrostyle 0.4 to 0.5 mm.

The male ampullae are scattered on the branches and are not numerous. They form low convex blisters, their surface being rougher and more porous than that of the surrounding coenosteum. Inner wall coarsely but not deeply fenestrated. Diameter of interior, which is oblate-spherical, 0.35 to 0.45 mm. Female ampullae not known.

The coenosteum is compact and hard, but the surface of trunk and base of branches is rougher than in *A. tylota*, being raised in low

vermiculations in the hollows of which are microscopic pores. On the smoother branches these pores appear as irregular, short sometimes branched slits, indicated in the drawing (pl. 42, fig. 1*c*). Other pores, about the size of the ordinary dactylopores, are scattered without order over the coenosteum.

Color of dried colony very pale buff, bleaching to white in hypochlorite solution. A second fragment is flushed with pale pink.

Type.—U.S.N.M. no. 43268.

Type locality.—Station 4781, off Agattu Island, Aleutian Islands, lat. 52° 14′ 30″ N., long. 174° 13′ E., 482 fathoms, fine gray sand, pebbles; bottom temperature 38.6° F.

Specimens examined.—The type colony and a fragment 50 mm long.

Remarks.—The structure of the colony resembles that of a specimen of *Stylaster profundiporus* Broch from Sagami Bay, Japan, but the likeness ends there. In *profundiporus* the dactylotomes are radially as long as the width of gastropore, which does not flare, trumpetlike, at the mouth. The dactylotomes cut deep in the wall of gastropore, and the intervening ridges between the dactylotomes are prominently decurrent on the sides of gastropore, as in *Allopora campyleca trachystoma.*

STYLASTER GEMMASCENS ALASKANUS, new subspecies

PLATE 47; PLATE 48; PLATE 54, FIGURE 2

Diagnosis.—Differing from *S. gemmascens* (Esper) [2] of the north Atlantic in the form of the prominent ampullae, which have an uneven rugose surface as if the wall were shrunk; and in the surface of coenosteum, which is thorny or traversed by fine ridges, sometimes decurrent from rim of cyclosystems. Colony flattened with a definite front and back, the majority of cyclosystems being on sides of branchlets, often at an angle so that the inner dactylotomes are destroyed or suppressed.

Description.—The characteristic form and posture of the cyclosystems are indicated by the figures (pls. 47, 48). The gastropore is usually funnel-shaped, broad at top, very narrow at bottom. There is a differentiated style chamber the top of which is marked by tiny spicules at about midheight of the slender spiculate gastrostyle. The upper flaring chamber of gastropore is about as deep as width of cyclosystem, or a little less. On the outside of the calyxlike cyclosystems are delicate decurrent ridges like the costae of madreporarian corals. These correspond to the septa between the dactylotomes.

The cyclosystems are usually asymmetrical in various ways. The greatest diameter measures 1 to 2 mm. Dactylopores 10 to 18, usually about 12; dactylotomes cut rather deep on sides of gastropore; gastrostyle very delicate, slender, inconspicuous, less than half as long as the gastropore axis.

[2] Broch, 1914, p. 8, pl. 1, figs. 4–7; pl. 2, fig. 16; pl. 3, figs. 21, 30; pl. 4, figs. 32, 33.

The ampullae are characteristic. The probable male ampullae are about 0.75 mm in diameter, about the same height, and the base is sometimes slightly constricted. The surface is very uneven (pl. 54, fig. 2; pl. 47; pl. 48, fig. 2). The probable female ampullae (pl. 47, fig. 3; pl. 48, fig. 1) are 1 mm in diameter. The surface is uneven, subrugose but less so than in the male, and there are no irregular protuberances such as usually characterize the male ampullae.

Coenosteum is of coarse texture. Surface of male fragments (e. g., pl. 48, fig. 2) is covered with unequal, compound, thorny outgrowths of very many different forms and sizes. These may form narrow, mostly longitudinal ridges on the face of colony, and also decurrent from the rim of cyclosystems. The surface of the female colony (pl. 47, fig. 3) is smoother, but on the peripheral branchlets are conspicuous smooth spiny outgrowths, sometimes extensions of septa of cyclosystems, sometimes independent.

Color of dried colony white or buffy white.

Type.—U.S.N.M. no. 43269.

Type locality.—Station 3480, Amukta Pass, Aleutian Islands, 283 fathoms, black sand, rocky.

Specimens examined.—Four fragments, three of which, including the type, are believed to be male and probably from the same colony; one believed to be female.

Remarks.—*Stylaster gemmascens* is recorded from such widely scattered localities as Indian Ocean (Milne Edwards and Haime), vicinity of Sulu Islands, 540 meters (Hickson and England), off Norway (G. O. Sars, Broch, and others). I have examined specimens from Trondhjemsfjord, kindly supplied by the Riksmuseum, Stockholm, through Dr. Sixten Bock. The United States National Museum possesses specimens from Norway (no. 15275). Now the species turns up along the Aleutian Islands, where the bottom water at 283 fathoms may be estimated, from readings at other stations, as between 37° and 38° F.

There is no precise information on the type specimen said to be in the Berlin Museum. Probably the *Siboga* specimen from off the Sulu Islands is very nearly typical, but Hickson and England (1905, p. 13) give no information on the ampullae. The north Atlantic specimens frequently have tubercles or blunt spines on the ampullae, but the walls are not strongly wrinkled as if badly shrunk, nor is the ampulla itself so prominent. So far as I can ascertain the surface of the coenosteum is not finely echinate or ridged as in the Alaskan form.

Quite apart from the improbability that a specific stock common to the north Pacific, north Atlantic, and tropical East Indies would be uniform, the fact remains that it is not homogeneous. Whether it is advisable to recognize geographical races depends upon viewpoint and whether implications of zoogeography are to be seriously regarded.

To state that the *same* species inhabits both the tropical East Indies and southern Bering Sea implies something vastly different from the statement that each region is occupied by a distinct race of the same species.

Stylaster eximius forma *minor* Hickson and England (1905, p. 11, pl. 1, figs. 7, 8) has been reported by Dr. Broch (1936, p. 22, fig. 3; pl. 1, fig. 3) from 1,076 meters, Okhotsk Sea. Dr. Broch's specimen differs from *alaskanus*, inter alia, in having a much shallower gastropore and a proportionately longer gastrostyle (Broch, 1936, fig. 3b). The style chamber is apparently not well differentiated. *S. g. alaskanus* has a much sturdier build and a rougher surface than *minor*, as indicated by figures of the type. All the *Siboga* specimens were taken in warm shallow water of the East Indies. It seems to me doubtful that this race would occur in the extremely cold water of Okhotsk Sea. At all events *Stylaster gemmascens alaskanus* is widely different from typical *S. eximius minor*.

STYLASTER CANCELLATUS, new species

PLATE 35, FIGURES 2–2*c*; PLATE 39; PLATE 40

Diagnosis.—Superficially resembling *Allopora polyorchis* but differing in its more delicate structure and its more freely anastomosing branches and branchlets devoid of spiny outgrowths; by its shallower and consistently funnel-shaped gastropores; and by the subspherical lumpy or corrugated female ampullae. Cyclosystems few on exposed surface of colony but relegated to lateral, protected face of branchlets.

Description.—As compared to *polyorchis* there are very few cyclosystems on exposed surfaces; rather they are crowded on the protected lateral face of the branchlets (pl. 39). These branches anastomose more freely than in *polyorchis* and the very irregular intervals of the net are often extremely narrow.

The gastropores average a little shallower than those of *polyorchis*, and the form is more often funnel-shaped (pl. 35, figs. 2, 2*b*, 2*c*) than the tubular form of *polyorchis* (pl. 35, fig. 1*d*). Where the branchlets are crowded and crooked the cyclosystems are quite asymmetrical in all sorts of ways. As in *polyorchis*, two or three gastropores may be surrounded by a series of dactylotomes, and in these (as well as in single distorted cyclosystems) the gastrostyle is likely to be thicker than in the normal symmetrical ones. From the branchlets that anastomose and form the net grow out very numerous short irregular twigs, which do not join another branch but help to fill in the available space between the already crowded branchlets. The terminal cyclosystem of such a twig is deeper and more symmetrical than the laterals usually are (pl. 35, fig. 2*b*).

The male ampullae are small, rounded-subconical, and densely crowded on both front and back of the branchlets, and overflow upon parts of the front of the principal stems; diameter 0.4 to 0.5 mm. The female ampullae are more spherical than in *polyorchis* and more decidedly rugose. The walls are deeply grooved, or the grooves are interrupted to form short irregular knobs connected by low ridges. The base of the ampulla is constricted, the wall thin, and the inner surface porous but not deeply fenestrated. Diameter of a female ampulla 0.75 to 0.85 mm, usually the latter.

Coenosteum smooth, hard, not appreciably different from that of *polyorchis* in texture. There are no thorny outgrowths.

Color pale buff, becoming pinkish buff after cleaning with sodium hypochlorite.

Type.—U.S.N.M. no. 43267.

Type locality.—Station 3480, Amukta Pass, Aleutian Islands, lat. 52° 06′ N., long. 171° 45′ W., 283 fathoms, black sand, rocky.

Specimens examined.—The type (fragment of female colony), the paratype, and two other fragments of a male colony.

Remarks.—This species has been contrasted with *Allopora polyorchis* since the two were taken at the same station and in early stages of my study were confused. However, *polyorchis* belongs to *Allopora* according to the standards now used to discriminate the group, whether as a genus or subgenus; *cancellatus* is very definitely not a form of *S. eximius;* nor do I believe it can be brigaded with *S. gemmascens.*

Genus ALLOPORA Ehrenberg

Allopora Ehrenberg, Abh. Akad. Wiss. Berlin, 1832, pp. 303, 371, 1834 (type: *Allopora oculina* Ehrenberg).

Stylantheca Fisher, Ann. Mag. Nat. Hist., ser. 10, vol. 8, p. 395, 1931 (type: *Stylantheca porphyra* Fisher).

ALLOPORA POLYORCHIS, new species

Plate 35, Figures 1–1*d;* Plate 37; Plate 38

Diagnosis.—Colony large, flabellate, with robust anastomosing main stems, and very numerous irregular branches, some of which coalesce with neighbors, the very irregular interspaces being narrower than the branchlets. Cyclosystems crowded, often confluent on sides of branches, numerous but spaced on front, sparse on back. Cyclosystems resembling those of *A. campyleca* but smaller, the gastropores generally straight on exposed front and back of colony and style chamber differentiated by a circlet of spicules; female ampullae with slightly rugose walls.

Description.—For form of colony, see plate 37. Its greatest breadth is 390 mm; height about 280 mm. Anterior and posterior aspects well differentiated, the branchlets arising from anterolateral

face of main stems; the latter densely beset on back with short thorns. Both surfaces of branchlets crowded with small conical ampullae, but cyclosystems mainly on front and lateral aspects of stems and branches. Cyclosystems spaced 2 to 4 diameters apart on front of colony while on lateral aspect of branchlets they are crowded, often irregular, and sometimes confluent.

Cyclosystems slightly smaller than in *A. campyleca*, with usually 8 to 12 deep but not very long dactylotomes, fairly conspicuous dactylopores, and small dactylostyles. Gastropore often shallower than in *campyleca* and frequently not curved (though often set obliquely on the branchlets), so that the slender to moderately robust style can be seen surrounded by a series of delicate spicules projecting downward from the pore wall (pl. 35, figs. 1*a*, 1*d*). These slender spicules are not regularly present in *campyleca*, which thus does not have a sharply differentiated style chamber. Diameter of cyclosystems 0.75 to 1 mm; depth of gastropore about 0.8 to 1 mm; gastrostyle, 0.4 to 0.5 mm.

On the lateral faces of the branchlets the cyclosystems are often asymmetrical and broader than on the front. Sometimes two or three cyclosystems merge in such a way that a series of dactylotomes surrounds a depression at the bottom of which are two to four funnel-shaped gastropores (pl. 35, fig. 1*c*) or two separate styles may occupy the bottom of a gastropore.

Male ampullae similar to those of *campyleca*, very numerous, small, conical. The dorsal wall is thin and the cavity is 0.25 to 0.35 mm in diameter, its surface deeply pitted, sometimes rough. Female ampullae: The only fragment I feel any confidence in assigning to this form has scattered hemispherical ampullae with uneven wall as if the contents had shrunk (pl. 35, fig. 1*b*); diameter, 0.85 mm to 0.9 mm.

The coenosteum is closely similar to that of *campyleca*. In less exposed portions the surface becomes rougher and more porous. The main stems of type are very thorny.

Color, pale buff, usually becoming pale pinkish after cleaning with sodium hypochlorite.

Type.—U.S.N.M. no. 43266.

Type locality.—Station 3480, Amukta Pass, Aleutian Islands, lat. 52° 06′ N., long. 171° 45′ W., 283 fathoms, black sand, rocky.

Specimen examined.—The type and numerous fragments, not all of which are broken from the type colony.

Remarks.—*A. polyorchis* comes near to falling in *Stylaster*, in the vicinity of *S. cancellatus*, as the cyclosystems are crowded in series on the lateral face of the branches so closely as to be frequently confluent. But other cyclosystems, generally smaller than these lateral ones, are numerous on the front of the colony, though seldom con-

tiguous. This peculiarity of the lateral cyclosystems is not found in *campyleca* or any of its subspecies.

The cyclosystems of *polyorchis*, except some of the distorted lateral ones, are smaller than in *campyleca*, with a gastropore that is usually straight where the coenosteum is thick enough to allow it. The septa between dactylotomes are not continued as decurrent ridges down the sides of the gastropore as in the case of *campyleca*. In *campyleca* the gastropores on small branchlets remain deep and curved, and appear never to assume the form shown by plate 35, figures 1*c* and 1*d*. The style chamber is definitely differentiated in *polyorchis*. The female ampullae are slightly wrinkled (pl. 35, fig. 1*b*).

The style chamber is fairly well developed in *A. campyleca paragea*, but its cyclosystems are smaller, especially those of the lateral aspect of the branchlets, and they are not at all crowded after the manner of *polyorchis*. The male ampullae are not so prominent and pointed-conical as in *polyorchis*, nor are the female ampullae wrinkled.

ALLOPORA CAMPYLECA, new species

PLATE 34; PLATE 36

Diagnosis.—Colony large, subflabelliform, with anastomosing branches; color very pale buff; cyclosystems prominent, projecting, mostly on one face of colony; dactylopores 8 to 15, narrow; length of dactylotome about one-third diameter of cyclosystem; dactylostyle very small, scarcely emerging above inner lip of pore; gastropore deep, narrow, curved; gastrostyle slender, sharp; ampullae very numerous, superficial, forming blisterlike convexities, those of male colonies about the diameter of gastropore; those of female colonies about the diameter of medium-sized cyclosystems.

Description.—Colony large, subflabelliform, with massive branches, which may anastomose at base of colony; branchlets often abruptly smaller than main branches, slightly flattened, irregular, with cyclosystems irregularly along sides, as well as on the front. On the more convex posterior face of branches and branchlets there are but few cyclosystems, although the pustulate ampullae encroach upon the posterior surface of branchlets. The type fragment, which is evidently only a part of a larger colony, is 180 mm by 90 mm, the main stem being 25 mm in diameter.

The cyclosystems are subcircular but vary to broadly elliptical, especially on sides of peripheral branchlets, and are abruptly raised above the general surface of the coenosteum from one-third to one-half the diameter of the system—occasionally even more on peripheral branchlets. Dactylotomes 8 to 15, commonly 9 or 10, narrow, with subparallel sides, the radial dimension usually a little less than a third

of total diameter of system; ridges between dactylotomes decurrent on sides of gastropore. Dactylostyle very small and as a rule not extending above the mouth of the slit as seen on side of gastropore. Gastropore deep and characteristically slightly curved, so that the slender style at the bottom is generally completely hidden when the cyclosystem is viewed directly from above (pl. 34, figs. 1, 1*b*). Diameter of a cyclosystem 1 to 1.3 mm; depth 2 to 2.5 mm. Gastrostyle 0.5 to 0.6 mm long. In male colonies the gastrostyle is likely to be much slenderer (pl. 34, fig. 1*e*) than in female colonies (pl. 34, figs. 1*f*, 1*g*).

On the periphery of larger colonies, branchlets may become flattened and cyclosystems distorted. Dactylotomes are commonly longer on the distal side of such cyclosystems.

Male ampullae are ordinarily about the diameter of a gastropore; low hemispherical to low subconical, the latter when crowded. They occur on all sides of the branchlets although more numerously on front and back; but they are very scarce on the back of the main stems. Female ampullae are nearly or quite as broad as the cyclosystems and hemispherical in form. The dome-shaped roof is thin, typically quite smooth. The subspherical interior presents a fenestrated surface. The smaller branches of female colonies, with their cyclosystems protruding from among the blisterlike ampullae, suggest *Stenohelia* (pl. 34, fig. 1*d*).

The coenosteum is hard, but the surface is microscopically uneven and porous, the pores being in the bottom of sinuous anastomosing microscopic depressions and are best seen on the younger parts of colony. On some of the peripheral parts of the colony, especially the back and sides of branches, but without any uniformity of occurrence, there are scattered tiny papilliform protuberances. Certain others, similar in size, have a definite central pore, representing perhaps secondary dactylopores. The paucity of their numbers suggests their unimportance to the colony.

Color of dried colony, light buff to ochraceous-buff (Ridgway's nomenclature); when cleaned with sodium hypochlorite the coenosteum becomes dull white, sometimes with a suggestion of very pale pink.

Type.—U.S.N.M. no. 42870 (fragment of male colony).

Type locality.—Albatross station 3480, Amukta Pass, Aleutian Islands, lat. 52° 06′ N., long. 171° 45′ W., 283 fathoms, black sand, rocky.

Specimens examined.—Numerous fragments (male and female) from the type locality. Also from station 2852, 2 small specimens; station 2858, 3 small specimens, not typical; station 3599, 5 small fragments; station 4230, small fragment; station 4302, small fragment.

ALLOPORA CAMPYLECA PARAGEA, new subspecies

PLATE 41, FIGURES 1–1*d*; PLATE 43

Stylaster (*Allopora*) *boreopacificus* forma *typica* BROCH (in part), Untersuchungen an Stylasteriden, p. 56, fig. 17, c, d, pl. 8, pl. 9, pl. 10, figs. 24, 25, 1936.

Diagnosis.—Differing from *boreopacifica* of Japanese Sea in having much deeper gastropores, at the bottom of which is a differentiated style chamber, the dorsal orifice of which (at about midheight of the style) is generally bordered by spicules. Differing from *campyleca* in having smaller cyclosystems with 5 to 11, usually 7 or 8, dactylotomes; the narrow often curved gastropore typically flares slightly, trumpetwise, at the mouth.

Description.—The principal colony forms are as follows: *a*, Compressed arborescent, such as the male type specimen and a small female fragment from station 4245; *b*, flabelliform, with thick main trunks and slender twigs, as the colonies figured by Broch, and the very imperfect large specimen labeled "Alaska"; *c*, flabelliform, with broad main stems and short, thick, flattened branches, represented by a small female colony from Sitka. The photograph gives a fair idea of the habit of the type specimen. Although the whole colony is flattened and hence subflabellate, it is a flattened bush, since the branchlets form several layers, one behind the other, without any coalescence. There is a well-marked front and back, the cyclosystems being scarce on the back of the main stems and large branches. Height of colony 130 mm, greatest width about 125 mm, but it was much larger before the branches were broken; maximum front to back extent toward periphery about 60 mm; diameter of main trunk at base about 25 mm, of peripheral branchlets about 1.5 to 2 mm.

Cyclosystems average a trifle broader than in typical *boreopacifica* and measure 0.6 to 0.85 mm in diameter. They are hence narrower than in *campyleca*. They project slightly above the surface; are widely scattered on front of larger branches; are more numerous on the branchlets, especially on the lateral faces, but are nowhere crowded. Gastropore often rather flaring at mouth, below which it narrows, and is normally deep and slightly curved, narrowing toward the bottom, where the style chamber is slightly better differentiated than in *campyleca*. Gastrostyle medium slender, lanceolate in profile, sharp, about 0.5 mm long. As may be seen from the figures, the 5 to 9 or 10 dactylotomes are rather short, owing to the usually flaring gastrostome, on the sides of which the slits cut about as deeply as their length seen from above. The dactylopore is small, deep. In many systems the dactylostyle is rudimentary; in others it is fairly well developed, but does not extend above mouth of pore proper.

When the cyclosystem of the branchlets is viewed directly from above, the gastrostyle is hidden by the curvature of the gastropore, but on the larger branches the style can usually be seen.

The male ampullae are scattered irregularly on branchlets, between cyclosystems, and are similar to those of *campyleca*. As noted above there is a female colony (60 by 40 mm) with thickened branches (Sitka), and one 75 by 55 mm with slender branches mostly in one plane (station 4245). The female ampullae are hemispherical, smooth, and slightly larger than the largest cyclosystems, but the wall is obviously thicker than in *campyleca* and the chamber relatively smaller as a consequence. Diameter of an average female ampulla of *campyleca* 1.1 mm; thickness of wall 0.05 to 0.06 mm. In *paragea* the same dimensions are 0.85 to 1 mm, and 0.14 mm. The interior is pitted but there are no spicules.

The coenosteum is hard and the surface smooth. Under strong magnification it shows the characteristic vermiculations—low ridges and anastomosing microscopic grooves between them. Surface not porous after cleaning with sodium hypochlorite. There are scattered small dactylopores penetrating the coenosteum, often at the apex of a low elevation.

Color of dried colony creamy white (type), pale buff (Sitka, station 4245); pale pink ("Alaska").

Type.—U.S.N.M. no. 42871.

Type locality.—Near Juneau, Alaska (Tenakee Springs). Depth and bottom not recorded. Specimen obtained by Dr. Willis H. Rich, of Stanford University.

Specimens examined.—In addition to the type, the following: Station 4245, 1 specimen, female; Sitka, Alaska, shrimp dredge, E. F. Ricketts, 1932, 1 specimen, female; Alaska, basal portion of large male colony and fragments of female colony; Alaska, Hans Jensen, 1 male specimen loaned by Dr. Hjalmar Broch (1936, p. 56).

Distribution.—Southeastern Alaska, Yakutat to Prince of Wales Island, in probably fairly shallow water to 95 fathoms.

Remarks.—This seems to be a southern shallow-water race of *campyleca*. The latter has been taken in deep water in southeast Alaska, but the specimens, though not typical, are nearer *campyleca* than *paragea*.

As I include all Dr. Broch's Alaskan specimens of *boreopacifica* forma *typica* in *paragea*, I should explain that I believe *paragea* has a different lineage from true *boreopacifica*, as exemplified by the type from St. Olga Bay, northeast of Vladivostok, Japan Sea. This conclusion is strengthened by a study of a form of *boreopacifica* from very cold water of Okhotsk Sea, recorded in this paper. The resemblance between *paragea* and *boreopacifica* is therefore fortuitous and in my opinion does not indicate very close relationship.

The gastropore in *paragea*, while somewhat variable in depth, is at least twice as deep as the length of the gastrostyle, and usually even

deeper, measured to the rim of the gastrostome as shown in the drawing (pl. 41, fig. 1*b*). Dr. Broch's drawing of the type of *boreopacifica* (1936, p. 57, fig. 17*b*) indicates a much shallower gastropore with a narrower mouth. His drawings of his Alaskan specimens (fig. 17*c*, *d*) indicate that the cyclosystem is broader than in the Asiatic type (fig. 17*a*). A good character of *paragea* is the slight expansion of the bottom of the gastropore to form a style chamber (pl. 41, fig. 1*c*). There are usually small spicules on the ridge marking the transition between this chamber and the pore above. In specimens cleaned with sodium hypochlorite (as for example the specimen from Alaska, Hans Jensen, listed by Dr. Broch and very kindly loaned for examination) these tiny spicules can be seen jutting from the wall, deep within the gastropore. No specialized style chamber is shown in Dr. Broch's drawings nor exists in the Okhotsk Sea form of *boreopacifica*. (See also Broch, 1932, fig. 2*d*.)

ALLOPORA CAMPYLECA TYLOTA, new subspecies

PLATE 41, FIGURES 2–2*e*

Diagnosis.—Differing from *A. campyleca* in the following particulars: More delicate structure of colony, presence of irregular spiculate outgrowths from the wall of gastrostyle chamber, differentiating the chamber from the portion above; a slender gastrostyle in female as well as in male colonies; generally radially shorter dactylotomes, with correspondingly wider gastrostome; more prominent female ampullae.

Description.—The material consists of four fragments of the main branches and eight of branchlets from one or more male colonies, and a fragment of a robust branch of a female colony. The complete colony may well have been as large as the type of *campyleca*, but was more open, with fewer anastomoses. The peripheral branches are more delicate, the lateral cyclosystems projecting two or three times their own diameter. There is a definite front and back, the latter without cyclosystems but with ampullae, except on largest branches. Length of largest fragment 95 mm; diameter of stem 14 mm.

The cyclosystems are scattered not thickly on front of the colony and form fairly regular series on the sides of the branchlets, frequently projecting conspicuously. The gastropore is deep, usually slightly curved, and the style is a little stouter than in the male of *campyleca*, there being no marked differences in the gastrostyles of male and female colonies. About midheight of the style irregular spicules project from the gastropore wall (pl. 41, fig. 2*a*). In some gastropores these spicules occur also below this point, on the walls of the thus differentiated style chamber (pl. 41, fig. 2*e*). Length of the finely spiculate style about 0.5 mm. There are usually about 12 to 17 dactylotomes, rather shorter than in typical *campyleca*, but as deeply

cut on side of gastropore, such cyclosystems measuring about 1 to 1.25 mm in diameter. There are smaller ones, with 10 to 12 pores, on the smallest branches; and in the female specimen there are numerous large ones (1.5 mm in diameter) with upward of 20 dactylotomes (pl. 41, fig. 2). Owing to small dactylopores and narrow dactylotomes the styles are extremely small, although the spicules extend above the mouth of the pore proper in many of the systems.

The male ampullae are very similar to those of *campyleca*, but the roof is a shade thicker. The female ampullae are even more prominent than in *campyleca*, usually projecting more than a true hemisphere, and have slightly thicker, spongier walls. The interior surface is usually deeply fenestrated, forming a coarse, spongy reticulum with irregular projections into the lumen, which is in some cases partly or even entirely occluded. Other ampullae have a fairly firm inner surface, which is simply irregularly pitted. The summit of some of the ampullae is very slightly irregular with incipient folds or knobs; others are perfectly smooth.

The coenosteum is similar to that of *campyleca*. In properly cleaned material the microscopic pores are even more evident.

Color pale buff, becoming pure white after cleaning with sodium hypochlorite.

Type.—U.S.N.M. no. 43263.

Type locality.—Station 4781, off Agattu Island, Aleutian Islands, lat. 52°14′30″ N., long. 174°13′ E., 482 fathoms, fine gray sand, pebbles; bottom temperature 38.6° F.

Remarks.—This form has been interpreted as a deeper water race of *A. campyleca*.

ALLOPORA CAMPYLECA TRACHYSTOMA, new subspecies

PLATE 45, FIGURE 2; PLATE 46; PLATE 54, FIGURES 1–1*b*

Diagnosis.—Colony ornate with massive irregular stems and often flattened branchlets which do not anastomose freely; coenosteum buffy pink, minutely roughened; cyclosystems with upward of 18 long, narrow, deep dactylotomes separated by rough coarsely porous septa, which *encroach upon the narrow gastrostome* and are continued, as decurrent ridges, on the walls of gastropore; the latter deep, slightly curved, and with a differentiated style chamber, the upper border of which is sparsely armed with spicules; style medium slender. Largest fragment 165 mm by 80 mm; main stem 30 mm in diameter.

Description.—The color is buffy pink, becoming a decided pale pink after cleaning with sodium hypochlorite. The colony is dendritic but compressed into an irregular flabellate form, the distal branches

often delicate and subdividing freely. There is a definite front and back, the protuberant cyclosystems being rather widely spaced on former, very few on latter. They are more numerous on the lateral faces of the branches, but when these are not compressed the cups are scattered on all surfaces. The smallest cyclosystems near end of branchlets have 9 or 10 dactylotomes; the full-sized systems, 12 to 18. The most trenchant characteristics of the cyclosystem are the deep and narrow dactylotomes and the spongy radial septa, which extend over the gastrostome and continue downward toward the style chamber as ridges on the wall of gastropore. As a result the gastrostome is conspicuously narrower than the pore below the level of the dactylotomes, as may be seen in a section view (pl. 54, fig. 1). The dactylotomes are deep, the slit descending conspicuously upon the wall of the gastropore. Diameter of full-sized cyclosystem 1 to 1.4 mm; depth of gastropore 2 to 3 mm; gastrostyle, 0.5 mm.

The peripheral branchlets are more or less flattened and on their sides the cyclosystems are usually asymmetrical, the distal dactylotomes being longer than the proximal (pl. 54, fig. 1*b*). There are also short flattened spinous outgrowths, especially on the lateral margin, or ambitus, of the branches, entirely independent of cyclosystems or ampullae (pl. 46, fig. 2). Cyclosystems are very scarce on the back of the colony. In several places branches have been broken off and new ones have grown from the truncated end.

Male ampullae small, as in *campyleca*, rather closely and irregularly scattered on the front and back of branches; their convex dorsal wall about half as thick as the diameter of the subspherical interior (which is 0.32 to 0.42 mm). Female ampullae resemble those of *campyleca* in form, but the surface is minutely roughened, or provided with small tubercles, or on peripheral parts of colony may be traversed by low, narrow, interrupted ridges (pl. 54, fig. 1*a*) giving a rugose appearance. The inner surface is pitted but is not particularly spongy or spiculate.

Coenosteum very hard; the surface not shiny but minutely roughened and porous; the texture accentuated on the septa of the cyclosystems and on surface of ampullae. The tiny vermiculations or interrupted irregular ridges to which the surface texture is due are beset with microscopic spicules similar to those of *brochi*.

Type.—U.S.N.M. no. 43265.

Type locality.—Station 4784, off East Cape, Attu Island, Aleutian Islands, lat. 52° 55′ 40″ N., long. 173° 26′ E., 135 fathoms, coarse pebbles.

Specimens examined.—Parts of two female colonies and of two male colonies.

ALLOPORA MOSELEYANA, new species

PLATE 49, FIGURE 2; PLATE 50; PLATE 51; PLATE 53, FIGURES 1–1*b*

Diagnosis.—Colony large, flabelliform, concavo-convex, grayish white with strongly differentiated stems and branches, both often anastomosing in mature colonies; cyclosystems prominent, with 7 to 12, generally 9 or 10, dactylopores and a fairly deep, usually straight gastropore; gastrostyle robust, pointed; cyclosystems very scarce on posterior face of colony; surface of coenosteum very compact, hard, lustrous.

Description.—Colony large, flabelliform, concavo-convex, with massive main branches, some of which anastomosing; branchlets very irregular, flattened, and springing from sides of the principal stems; only a few from concave front of colony and occasionally a short abortive twig from the back. Length of type (only a part of a larger colony) 190 mm; width 160 mm.

The cyclosystems are normally protuberant from one-fourth to about their own diameter. On the lateral face of branchlets, which are close to other branchlets, the cyclosystems are usually flush with the surface, a very neat adaptation to the necessities of their situation. Dactylotomes 7 to 12, usually 9 or 10, with subparallel sides, the radial dimension commonly about one-fourth total diameter of system. The spiculate dactylostyle extends slightly above mouth of pore as seen from side of gastropore. Gastropore rather deep, with a well-defined ventral chamber, the upper margin of which is spiculate and surrounds the style at about midheight. Depth of gastropore two and one-half to three times length of style. Gastrostyle robust, spiculate, 0.45 to 0.6 mm in length and 0.25 to 0.3 mm in diameter. As viewed from above the style occupies a conspicuous portion of the width of the gastropore, especially in those cyclosystems on the exposed front of the colony. The style shown in plate 53, figure 1, is of minimum width. Diameter of cyclosystem 0.85 to 0.9 mm; depth 1.2 to 1.7 mm.

Male ampullae superficial, numerous on back of the branchlets (but not main branches) and also on front (pl. 51; pl. 53, figs. 1 and 1*b*, a). They form circular, abruptly convex swellings (a little less than the diameter of a cyclosystem), which are usually provided with an apical differentiated protuberance (often perforated) and sometimes carry also accessory, often smaller, protuberances evidently the same as those scattered on surface of coenosteum. Cavity of ampulla subspherical, its inner surface deeply fenestrated and with irregular thin protruding laminae and flattened chisel-shaped spicules. There appear to be a few deeper-lying ampullae. Female ampullae (pl. 49, fig. 2; pl. 50) larger, low hemispherical, with a smooth outer surface. Surface of cavity not so rough as in male.

The coenosteum, when cleaned, is hard, compact, smooth, lustrous, and without the microscopic pores of *Allopora campyleca*, although on the branchlets the surface shows irregular low, vermiculate, anastomosing ridges, rather pronounced near the cyclosystems. There are scattered, granuliform protuberances, especially on the smaller branches. Small pores about the size of a dactylopore, or smaller, are widely scattered between the cyclosystems (pl. 53, fig. 1, *b*, p).

Color of dried colony grayish white; when cleaned with sodium hypochlorite the coenosteum changes to pinkish white.

Type.—U.S.N.M. no. 42869.

Type locality.—Station 4781, Bering Sea near Agattu Island, lat. 52° 14′ 30″ N., long. 174° 13′ E., 482 fathoms, fine gray sand and pebbles; bottom temperature 38.6° F.

Specimens examined.—The type in several fragments. Also from station 3480, 7 fragments (2 male, from 2 colonies; 5 female, from possibly as many different colonies).

Remarks.—Through the cooperation of Dr. Broch I have been able to compare the type of *moseleyana* with the cotype of *Allopora scabiosa* (Broch). The two species are probably rather closely related but perfectly distinct. In *scabiosa* the surface of the coenosteum, when carefully cleaned, is not glossy or so close-grained as in *moseleyana*, nor are the cyclosystems so protuberant. In *scabiosa* there is not a sharply differentiated style chamber at the bottom of the gastropore, nor are there spicules protuberant from the wall at about midheight of the gastrostyle as in both forma *moseleyana* and forma *leptostyla*. The style of *scabiosa* is much slenderer than in typical *moseleyana* but not slenderer than in forma *leptostyla* (which, however, has a well-developed style chamber, if anything more spiculate than that of forma *moseleyana*). The gastropore of *scabiosa* is usually slightly curved, and is more *funnel-shaped* than cylindrical.

In the specimens of *scabiosa* the female ampullae are convex to the same degree as in *moseleyana*. The male ampullae are also superficial and convex, but they seem never to carry the tubercle or tubercles which characterize those of *moseleyana*.

I have seen a colony of *Allopora norvegica* (Gunnerus) from Trondjhemsfjord, Norway, which has a lustrous, hard, whitish coenosteum like that of *moseleyana*. A young male colony of the latter species greatly resembles this Trondjhemsfjord example in form of colony and distribution of cyclosystems. But in *A. norvegica* there are 4 to 9, usually 5 to 7, dactylotomes, which cut much deeper into the side of the gastropore. The gastrostyle is broad, blunt, sometimes subhemispherical. The ampullae are imbedded in the branches and do not form conspicuous superficial convexities.

The architecture of the type of *moseleyana* resembles that of *Allopora profunda* Moseley from 600 fathoms off the mouth of Rio de

La Plata. In Moseley's species there are 12 to 16 dactylotomes, while the gastrostyle is much slenderer and shorter than in *moseleyana*. According to Moseley's figure (Moseley, 1879, pl. 39; also pl. 35, fig. 13) the style in length equals about one-fifth the depth of the gastropore. In *profunda* the ampullae are much smaller and "are usually entirely sunk beneath the surface, but sometimes near enough to it in situation to raise upon it very small conical elevations, which easily escape notice, and are present only here and there. The ampullae are present in abundance *in the walls of the pore systems* and at their bases."

This species is named in memory of H. N. Moseley.

ALLOPORA MOSELEYANA forma LEPTOSTYLA, new

PLATE 52

Diagnosis.—Differing from *A. moseleyana* in having a distinctly slenderer gastrostyle, which does not crowd the style chamber, and in having male ampullae, which form smaller superficial blisters.

Description.—There are two fragments of large branches, which indicate that this form grows to a considerable size. The type (pl. 52, fig. 2) is apparently a young colony.

The form of the cyclosystems does not differ materially from that of *moseleyana*. Dactylopores 7 to 12; dactylotomes radially as in *moseleyana;* gastrostome often slightly constricted. Gastropore averages a little shallower than in forma *moseleyana*. Style chamber well differentiated. The gastrostyle is about 0.5 mm long, slender, cylindrical-lanceolate in lateral profile. Diameter of cyclosystems 0.75 to 0.95 mm; depth of gastropore 1 to 1.2 mm. On each of two truncated branch-ends caused by fracture, two cyclosystems have regenerated.

Male ampullae (pl. 52, fig. 1) small, forming low conical protuberances, the width of which is less than that of cavity of ampulla (0.5 mm). Interior wall as in *moseleyana*. Female ampullae like those of *moseleyana* (pl. 52, fig. 3).

Color of dried colony very pale buff, bleaching to white in sodium hypochlorite solution.

Type.—U.S.N.M. no. 43270.

Type locality.—Station 3480, Amukta Pass, Aleutian Islands, lat. 52° 06′ N., long. 171° 45′ W., 283 fathoms, black sand, rocky.

Specimens examined.—From type locality: Type and parts of 2 other male colonies; 4 fragments of at least 2 female colonies.

Remarks.—This form appears to be a variant of *moseleyana*, as indicated. When the extraordinary number of species and subspecies dredged at station 3480 is taken into consideration, the question of hybridism is sure to arise; but there is absolutely no information upon which to base an answer.

ALLOPORA SCABIOSA (Broch)

PLATE 76, FIGURES 7, 8

Stylaster scabiosa BROCH, Einige Stylasteriden (Hydrokorallen) der ochotskischen und japanischen See, p. 60, 1935.

Stylaster (*Allopora*) *scabiosa* BROCH, Untersuchungen an Stylasteriden, p. 72, fig. 24, pl. 12, figs. 32, 33, 1936.

Diagnosis.—Color red to pale warm pink; colony slenderly built, branching mostly in one plane; cyclosystems on all sides of peripheral branchlets; back of principal branches and stem almost without cyclosystems. Dactylotomes 7 to 15, mostly 8 to 11, cutting rather deep on side of gastropore, the sides parallel as viewed from above; gastropore about as deep as in *moseleyana*, but often slightly curved, more funnel shaped, with a less definitely differentiated style chamber; style slender.

Type locality.—Okhotsk Sea, lat. 54° 53′ N., long. 144° E., 505 meters, bottom temperature 1.44° C.

Specimens examined.—Three fragments (cotypes).

Remarks.—In general habit this species is superficially like *S. norvegicus pacificus* but differs in having a more open funnel-shaped gastropore, smaller gastrostyle, more numerous dactylopores, and superficial ampullae. In the three fragments of the cotype sent me by Dr. Broch, the ampullae are in two distinct sizes. The larger, which I would call female, are low-convex, much lower than broad, and of about the diameter of a cyclosystem. They are very numerous on a dichotomously branched twig 20 by 30 mm. Two other branchlets have what I should call "male" ampullae, only half the size of the "female." These are nearly as prominent as in *A. moseleyana* and are similar in character to ampullae called "male" in other species, e. g., *S. cancellatus*, *A. polyorchis*.

Dr. Broch describes, however, only male gonophores. Whether these came from both sorts of ampullae or only the larger ones is not clear. Perhaps the use of the term male and female is ill-advised for material that is, oftener than not, dried. In *Cryptohelia* the larger ampullae are known to hold planulae. The small ampullae, called male, are not immature stages of the large ones, called female, since they frequently differ in form. They sometimes, as in *moseleyana*, are perforated as if for escape of sperm.

For a full description of *A. scabiosa*, Dr. Broch's paper should be consulted. He sums up the systematic position of *scabiosa* as follows:

"*Stylaster scabiosa* exhibits great similarity to a lightly built *Stylaster norvegicus* and in certain respects occupies an intermediate position between the latter and *S. boreopacificus*, but differs from both in having a much higher dactylopore count."

ALLOPORA SOLIDA (Broch)

PLATE 76, FIGURES 1, 2

Stylaster solidus BROCH, Einige Stylasteriden (Hydrokorallen) der ochotskischen und japanischen See, p. 60, 1935.

Stylaster (*Allopora*) *solidus* BROCH, Untersuchungen an Stylasteriden, p. 68, fig. 22, pl. 9, fig. 30, 1936.

Diagnosis.—Branches coarse, subterete, with slightly raised, well-spaced cyclosystems on all sides; no differentiated front and back; cyclosystems with 4 to 9, mostly 5 to 7, narrow dactylotomes, very shallow at gastropore end; gastropore very narrow, cylindrical, sometimes slightly curved, but usually oriented perpendicular to surface; Gastrostyle large, but only medium stout, and tapered regularly from base to a sharp point, its length half to two-thirds depth of gastropore; no differentiated style chamber; ampullae only slightly convex, not rugose.

Description.—The cyclosystems are very characteristic in having narrow dactylotomes, with parallel sides, as long as width of gastrostome and shallowly cut at inner end. The angular septa between the dactylotomes may slightly overhang the gastropore as in *stejnegeri* and *brochi*. The dactylopore proper is large and provided with a conspicuous style. When the cyclosystem is viewed directly from above, the wall separating dactylopores from gastropore appears as a definite ring (the top of which causes the shallow inner end of dactylotome). The surface of gastropore is pitted and roughened by irregular longitudinal ridges, but these are not decurrent from the septa as in *brochi*. The gastrostyle is long-conical, rather slender, not at all constricted at base, and ends in a sharp point. Diameter of cyclosystem 0.9 to 1.15 mm. Depth of a sample gastropore 0.95 mm; length of gastrostyle 0.6 mm, breadth at bottom 0.28 mm. The gastrozooids are without tentacles (Broch).

The female ampullae cause only a slight swelling of the surface, as in *A. verrilli*. This "roof" is 0.25 mm thick, the cavity 0.85 mm wide by 0.5 mm high; its surface is rough with many delicate spicules.

The coenosteum is hard with the characteristic finely vermiculate etching of the surface.

Color: Bright salmon pink to rose.

Type locality.—Okhotsk Sea, lat. 56° 24′ N., long. 143° 18.5′ E., 100 meters; temperature in 95 meters, 1.34° C.

Specimen examined.—A fragment of the type material, marked cotype, loaned by Dr. Broch.

Remarks.— Apropos of the absence of gastrozooid tentacles in this species, certain gastrozooids of *A. porphyra* lack tentacles apparently as a normal though infrequent variation.

A. brochi and *A. stejnegeri*, which have narrow cylindrical gastropores, differ from *A. solida* in the different type of colony, the noticeably convex ampullae. *A. stejnegeri* has rugose ampullae and a much smaller gastrostyle. *A. brochi* has deep-cut dactylotomes with decurrent ridges on sides of gastropore, a deeper, curved gastropore, and *relatively* smaller gastrostyle.

A. solida differs from *A. verrilli* in its narrower gastropore, that of *verrilli* being wider at mouth than the length of dactylotomes, and funnel shaped, not cylindrical. Its dactylotomes are characteristically constricted between dactylopore and gastropore as in *A. californica*.

ALLOPORA BROCHI, new species

PLATE 42, FIGURES 3–3*d*; PLATE 44; PLATE 45, FIGURE 1

Diagnosis.—Colony buff pink, small, with robust blunt branches produced in all directions, and without a definite front and back; cyclosystems well spaced, protuberant, distributed on all surfaces; differing from *A. solida* in the projecting cyclosystems, deeper gastropore, deeper dactylotomes, and more conspicuous, low-convex ampullae.

Description.—The form of the colonies is typical of a heavily built *Allopora* as the protuberant cyclosystems are about evenly distributed on all sides of the thick branchlets, which are somewhat flattened or compressed, with truncate and rounded ends. Type, 80 mm high; 50 mm greatest width.

The cyclosystems resemble those of *trachystoma* but are smaller, and the septa do not encroach so much upon the gastrostome. The dactylotomes, commonly 7 to 10 in number, are narrow and deep, and the dactylopore is rather occluded, as indicated in plate 42, figure 3. The gastropore is deep, narrow, curved as a rule, and of nearly uniform width (pl. 42, fig. 3*b*). As in *trachystoma* the septa are continued as low ridges far down the side of the pore, which is smooth, except for a variable number of small, scattered spicules at the lower end. This style chamber is not sharply differentiated from the part above. The gastrostyle is medium slender, but sometimes a short conical one is found as if it might be regenerating, although no injury to the pore is apparent (pl. 42, fig. 3*d*). The gastrostyle, surrounded by narrow, interrupted lacunae, may be traced into the coenosteum for a distance equal to its own length. Diameter of cyclosystems 0.68 mm to 1.2 mm; depth of gastropore 1.8 mm to 2 mm; style, 0.5 to 0.6 mm.

The female ampullae are evenly low-convex, with a granulated surface (pl. 42, figs. 3*a* and 3*b*). The dorsal wall is rather thick, and the inner surface is pitted and fenestrated but not spiculate. The

ampullae are unevenly distributed on all surfaces; not crowded. Diameter of ampullar chamber 0.6 mm to 0.9 mm. Male unknown.

The surface of the coenosteum is minutely porous and has a granulated appearance due to tiny vermiculations or interrupted irregular ridges, the surface of which is closely beset with microscopic crystal-like spicules, similar to those of *trachystoma.* There are rather numerous scattered, tiny dactylopores.

Color buff pink, becoming pale pink after cleaning with sodium hypochlorite.

Type.—U.S.N.M. no. 43264.

Type locality.—Station 4777, Petrel Bank, Bering Sea, lat. 52° 11′ N., long. 179° 49′ E., 52 to 43 fathoms, fine gravel; 2 specimens.

Remarks.—*A. brochi* is not especially like *solida* except in having a narrow gastropore and constricted gastrostome. This feature is found also in *trachystoma* which is believed to be nearly related to *A. campyleca.* If the position of the ampullae is really significant, *A. brochi* is quite definitely unlike *solida.* The growth habit of the two species is different, *solida* having coarse, subterete, anastomosing branches composing probably a very massive colony.

This species is named in honor of Dr. Hjalmar Broch, of Oslo, Norway.

ALLOPORA STEJNEGERI, new species

PLATE 42, FIGURES 2–2*b*; PLATE 56

Diagnosis.—Colony lobed, rather than branched; cyclosystems not protuberant, fairly evenly spaced on all surfaces, with usually 6 to 8 narrow, clean-cut dactylotomes, a narrow, cylindrical moderately deep gastropore, and relatively small gastrostyle; ampullae low-convex, ridged or rugose superficially. Differing from *A. solida* in the more prominent ampullae, deeper dactylotomes, and relatively smaller gastrostyle, as well as in the form of colony and its rougher surface.

Description.—Type colony with short, thick, irregular branches (pl. 56, fig. 2); greatest width 70 mm; height 40 to 60 mm, according to angle of measurement.

The cyclosystems have long, narrow, sharply cut dactylotomes, 5 to 12, ordinarily 6 to 8, in number, the width being uniform, not constricted adjacent to gastropore as in *verrilli.* The dactylostyles are so small as to be rudimentary, whereas in *verrilli* they are well developed. The dactylotomes are shallower than in *verrilli,* where they cut deep on the sides of gastropore. The gastropore is usually slightly curved on the distal parts of the colony. Gastrostyle rather small, loosely put together (pl. 42, fig. 2*b*); no well-differentiated style chamber. Diameter of large cyclosystem 1.2 mm; depth of gastropore 1.5 mm.

Female ampullae (pl. 42, fig. 2*a*; pl. 56, fig. 1): The convex surface is thrown into rather sharp uneven ridges, or into irregular short tubercles, or both. Sometimes the ridges radiate irregularly from summit of convexity. Here and there are abruptly smaller ampullae, which may be seen in the photograph (also pl. 42, fig. 2*b*). It cannot be determined in the dry specimen, whether these are male ampullae or undeveloped female. Male colony unknown.

Coenosteum close-grained, hard, smooth on the main limbs, but on the branches roughened by low ridges and protuberances similar to those of ampullae (pl. 56, fig. 1).

Color, pale warm pink (light grenadine pink or orange-pink of Ridgway's nomenclature).

Type.—U.S.N.M. no. 43271.

Type locality.—Station 4777, Petrel Bank, Bering Sea, lat. 52° 11′ N., long. 179° 49′ E., 52–43 fathoms, fine gravel.

Specimens examined.—The type.

Remarks.—*Allopora stejnegeri* differs from all other species of red, pink, or purplish *Allopora* in the character of the ampullar wall, which is rugose, or ridged. The dactylotomes have clean-cut, sharp edges and are of uniform width. The gastropore is narrow, fairly deep, cylindrical.

This sharply differentiated *Allopora* is named in honor of Dr. Leonhard Stejneger, of the United States National Museum, dean of American taxonomers.

ALLOPORA BOREOPACIFICA (Broch)

PLATE 53, FIGURES 3–3b; PLATE 55, FIGURE 2; PLATE 76, FIGURES 9–11

Stylaster (*Allopora*) *boreopacificus* BROCH, Explor. des Mers d'URSS, fasc.17 (1933), Inst. Hydrologique Leningrad, pp. 82, 84, figs. 1, 2, 1932; Einige Stylasteriden (Hydrokorallen) der ochotskischen und japanischen See, p. 60, 1935.

Stylaster (*Allopora*) *boreopacificus* forma *typica* BROCH (in part), Untersuchungen an Stylasteriden, p. 56, text fig. 17*a*, *b*, 1936; figs. 17*c*, *d*, and pls. 8–10 (figs. 24, 25 refer to *A. campyleca paragea*).

Diagnosis.—Cyclosystems small, with usually 5 and 6 (Okhotsk Sea), or 7 and 8 (Gulf of Tartary), narrow dactylotomes about as long as width of gastrostome; gastropore rather narrow, sometimes slightly curved, 0.8 to 0.9 mm deep, cylindrical, without a style chamber; gastrostyle slender, sharp, half as long as depth of gastropore; ampullae (female) conspicuous, slightly convex superficially, about twice as broad as cyclosystem; coenosteum minutely perforated, pink.

Description.—The material does not conform absolutely to the type specimen from St. Olga Bay, on the Asiatic coast at mouth of Gulf of Tartary, but the deviations are no greater than may be expected. Dr. Broch's material from the type locality was limited to a small fragment of the original specimen, a sketch of which appears

in Broch, 1932 (fig. 1). This shows a colony 120 mm high, somewhat flabellate in form, with heavy trunk and main branches, and numerous branchlets, some of which are in one general plane while others are in different planes. The *Albatross* material (1906) consists of small clusters of branchlets and twig ends evidently broken from a large colony (pl. 55, fig. 2).

Cyclosystems of branchlets very small, and frequently asymmetrical or incomplete, as shown in plate 53, figure 3*a*. These may have the lower rim of cyclosystem slightly raised while upper margin, with incomplete or suppressed dactylopores, is flush with general surface. Symmetrical systems have the rims raised about as much as in *pacifica*. Dactylotomes 1 to 9, most commonly 5 and 6, proportionately about as deep as in *pacifica* but distinctly narrow, while the whole cyclosystem is smaller. Plate 53, figure 2, represents an average cyclosystem of *pacifica* (0.8 mm). Dr. Broch records cyclosystem diameter of *pacifica* as high as 1.3 mm. Dactylostyle very poorly developed, much less so than in *pacifica*. Gastropore narrow, rather deep, sometimes slightly curved, or its axis oblique rather than at right angles to surface, of about the same shape as in *pacifica* and without a differentiated style chamber at the bottom. The pore is thus nearly cylindrical and does not widen conspicuously at gastrostome. Style slender, its length about half depth of gastropore; the latter is slightly deeper than in the type. The styles vary somewhat but are never robust as in typical *pacifica*. Diameter of cyclosystem 0.5 to 0.75 mm; depth of gastropore 0.9 mm; length of gastrostyle 0.4 to 0.5 mm.

In a male specimen certain of the cyclosystems have only 1, 2, or 3 dactylotomes.

Ampullae (female) low-convex, nearly or quite twice as broad as adjacent cyclosystems, among which they may be as thickly placed as the space will permit. The surface is smooth. Diameter outside 1.0 to 1.2 mm; of cavity 0.9 to 1.0 mm; height of cavity 0.6 mm; convex roof 0.15 to 0.25 mm thick.

In contrast to *pacifica* the surface of coenosteum is not lustrous and is microscopically perforated, the perforations in the form of interrupted, very irregular, often branched slits narrower than the intervening trabeculae.

Color of dried colony: Pale pink; bright rose (Broch).

Type locality.—St. Olga Bay, northeast of Vladivostok, mouth of Gulf of Tartary, 100 meters, small stones.

Specimens examined.—Okhotsk Sea (stations 5016 and 5017) numerous fragments. The bottom temperature of 29.8° F. is noteworthy. Twenty-three stations in the southern part of Okhotsk Sea made by the *Albatross* (1906) in 52 to 192 fathoms gave bottom readings of 29.8° to 32.1° F.

Remarks.—In the type of *boreopacifica*, dactylopores of 50 cyclosystems ranged as follows: 5 had 6 dactylopores; 17 had 7; 15 had 8; 8 had 9; 4 had 10; 1 had 11. Seven and 8 therefore occur most frequently, whereas in the Okhotsk Sea specimens 5 and 6 are more frequent than 7 and 8, and 3 and 4 occur on the smaller branchlets. As the higher counts are found on the proximal parts of the fragments, it is likely that a complete colony would show a higher percentage of 7 and 8.

This species has the smallest cyclosystems of any of the north Pacific Alloporas.

ALLOPORA VERRILLI Dall

PLATE 54, FIGURE 3; PLATE 57; PLATE 76, FIGURES 5, 6

Allopora verrilli DALL, Proc. Biol. Soc. Washington, vol. 2, p. 111, 1884.—FISHER, Ann. Mag. Nat. Hist., ser. 10, vol. 8, p. 391, 1931.

Allopora moseleyi DALL, Proc. Biol. Soc. Washington, vol. 2, p. 113, 1884.

Stylaster (*Allopora*) *norvegicus* forma *pacifica* BROCH (Strait of Georgia record), Untersuchungen an Stylasteriden, p. 52, 1936.

Diagnosis.—Colony small, forming lumpy incrustations, broad-lobed subflabellate upright masses, or little trees with robust to slender branches (pl. 57, figs. 1–3). Cyclosystems medium-sized, with 4 to 11 fairly long, deep, subequal dactylotomes, constricted adjacent to gastropore, the sides of which slope inward toward the robust, pointed style, which fills the bottom; gastropore not deep; dactylostyles well developed. Male and female ampullae forming only slight convexities of surface of coenosteum.

Description.—The cyclosystems (1 to 1.25 mm in diameter) usually have 6 or 7 (5 to 11) dactylotomes characteristically broader at the outer end. The finely spiculate dactylostyle is conspicuous, differing therein from *A. steynegeri* and agreeing with *A. californica*. In some cyclosystems the dactylotomes may be larger on one side (as in *californica*) but this is not characteristic of the species. The gastropore is also much like that of *californica* in that it is narrowly funnel-shaped and is completely filled at bottom by the pointed style (pl. 54, fig. 3). The surface of gastropore is very rough, with tiny blunt protuberances.

The female ampullae are sunken in the coenosteum, the roof forming only a slight superficial convexity. The chamber is subspherical, about 0.75 mm in diameter. Its inner surface is rough but not intricately fenestrated or spiculate like the interior of gastropore.

Some of but not all the male ampullae form slight superficial convexities. The chamber is subspherical, 0.25 to 0.5 mm in diameter.

When thoroughly cleaned with sodium hypochlorite the surface of coenosteum presents a somewhat "sugary" appearance, more compact at base of colony than at ends of branches. The surface is fairly smooth, marked by fine vermiculations and perforated by microscopic

pores. There is no sign of the numerous surface papillae characteristic of *californica*, *papillosa*, and *porphyra*.

Color, dried, pale warm pink (orange-pink of Ridgway's nomenclature, becoming shrimp pink or safrano pink after treatment with sodium hypochlorite).

Type.—U.S.N.M. no. 4193.

Type locality.—Chika Islands, Akutan Pass, Aleutian Islands (near Unalaska).

Specimens examined.—The types, 5 specimens that had been thrown on beach. All are incrustations, chiefly on *Mytilus* shells and are more or less beach-worn. The best specimen is figured (pl. 57, fig. 3). Also from station 4777, 2 specimens (one on small stone, the other on fine cemented gravel).

Sucia Islands (vicinity of San Juan Islands), Wash., depth not recorded; 14 small colonies, all on large water-worn pebbles (pl. 57, fig. 1).

ALLOPORA NORVEGICA PACIFICA (Broch)

PLATE 53, FIGURES 2–2*b*; PLATE 55, FIGURE 1; PLATE 76, FIGURES 3, 4

Stylaster (*Allopora*) *norvegicus* BROCH, Einige Stylasteriden (Hydrokorallen) der ochotskischen und japanischen See, p. 59, fig. 2, 1935.

Stylaster (*Allopora*) *norvegicus* forma *pacifica* BROCH, Untersuchungen an Stylasteriden, p. 52, fig. 15, pl. 6, figs. 18, 19, 1936.

Diagnosis.—Colonies salmon pink, rose, or white, branching more or less dichotomously mostly in one plane; branches subterete, the medium-sized cyclosystems rather uniformly spaced on front of colony, scarce on back except at tips of branches; ampullae not forming superficial convexities except sometimes very slight ones near ends of branches. Resembling *A. verrilli*, but with narrower, deeper, cylindrical gastropores and less superficial ampullae.

Description.—The colony form is flabellate with robust branches of rather uniform thickness. The front of a characteristic fragment is shown by plate 55, figure 1. The back of the principal branches is usually nearly free from cyclosystems, but these appear at the ends of the branchlets.

The margin of the cyclosystems is slightly to decidedly raised above the level of coenosteum. In the *Albatross* specimens there are 3 to 9 dactylopores, usually 5 or 6. But in a count of 50 cyclosystems on each of 4 colonies, Dr. Broch found 7 in 65 instances, 6 in 5, 8 in 42, 9 in 18, 5 in 15. His colony no. 4, having a maximum of 8 dactylopores, corresponds more nearly with my material. The dactylotomes are deep cut extending ventrally about one-third depth of gastropore. In my specimens the radial dimension is much less than in Dr. Broch's, being about half width of gastrostome, while in the type material the length equals or slightly exceeds gastrostome width. In the type material the dactylotomes are rather narrow with subparallel sides as in *brochi;* in my specimens there is considerable varia-

tion, as they may be slightly expanded at the outer or dactylopore end, as in *verrilli* (pl. 53, fig. 2). Dactylostyle fairly conspicuous and extending well above mouth of slit as seen from inside of gastropore (pl. 53, fig. 2*b*). The gastropore is cylindrical or slightly constricted at about midheight of style. It is not so wide at gastrostome as in *A. verrilli;* hence is not at all funnel shaped but may be even a trifle narrower at mouth than midway to bottom. The style chamber exists only as a slight expansion at bottom and is not differentiated from the part above by special spicules. Ordinarily the gastrostyle is robust about twice as high as broad, broadly lanceolate in profile with an acute tapered end; length 0.5 to 0.6 mm in largest cyclosystems. Owing to the oblique direction of gastropore into coenosteum or to its occasional slight curvature the style may be invisible when colony is held horizontally.

Diameter of cyclosystem of type material 0.8 to 1.3 mm (Broch). In the *Albatross* specimens the diameter of the largest cyclosystems with 7 or 8 dactylopores is 0.8 to 0.85 mm; depth of larger gastropores 1.2 mm.

Puzzling variation is furnished also by four small fragments in which the cyclosystem structure is closely similar to that of other specimens, but the gastrostyle is much slenderer (pl. 53, fig. 2*a*). These specimens have been compared with the cotype of *A. solida* and are definitely not that species. The very shallow dactylotomes of *solida* are characteristic. In two sectioned cyclosystems of one of Dr. Broch's white colonies I find gastrostyles slenderer than fig. 2*b*, and therefore *much slenderer* than Dr. Broch's figs. 15*b*, *c* (1936, p. 53).

There are rather numerous instances of one or two dactylopores forming part of a cyclosystem but without a dactylotome connection to gastropore (Broch, 1936, p. 53, fig. 15*d*).

The ampullae are sunk beneath the surface and are of 2 sizes. The smaller (pl. 53, fig. 2*b*) have a subspherical cavity, 0.4 to 0.5 mm in diameter, while the larger are 0.65 to 0.85 mm broad and 0.4 to 0.5 mm high. In these I found one or two structures (desiccated for over 30 years) which may represent planulae. On softening, clear spots resembling nematocysts were plainly visible.

Coenosteum hard, rather lustrous, minutely reticulated and roughened, the reticulations representing hollows or fine grooves separating microscopic irregular ridges which reflect light. On the rim of the cyclosystems the texture is a little coarser and the coenosteum irregularly perforated or fenestrated, while the wall of gastropore is perforated and roughened by irregular convexities.

Color of dried colony, pale warm pink to salmon red (grenadine pink to dull flame scarlet of Ridgway's nomenclature). Dr. Broch records two white colonies, one of which I have seen.

Type locality.—Okhotsk Sea, lat. 56°10′ N., long. 143°15′ E., 182 meters, bottom temperature 0.51° C.

Specimens examined.—Okhotsk Sea (stations 5016 and 5017), numerous fragments; two of Dr. Broch's types.

Remarks.—It is noteworthy that the bottom temperature at station 5016 was 29.8° F., therefore lower than at the type locality.

Dr. Broch examined one of my specimens from station 5016 and identified it as *pacifica*. It is nevertheless rather different from his material. Added to this is the confusing matter of two gastrostyle sizes in my specimens. If these are all one species, it is certainly a variable one.

Dr. Broch writes me that the record of *pacifica* from 60 fathoms, Strait of Georgia, pertains to *A. verrilli*.

ALLOPORA CALIFORNICA Verrill

PLATE 58; PLATE 61, FIGURES 3–3*b*

Allopora californica VERRILL, Proc. Essex Inst., vol. 5, no. 3, p. 37, 1866; Trans. Connecticut Acad. Arts and Sci., vol. 1, p. 516, pl. 10, fig. 8, 1868.—FISHER, Ann. Mag. Nat. Hist., ser. 10, vol. 8, p. 392, pl. 15, figs. 3–3b, 1931.

Diagnosis.—Cyclosystems flush, very numerous, with slightly raised margin and 4 to 8 (ordinarily 6 or 7) unequal, prominent dactylotomes slightly constricted adjacent to gastropore; gastropore narrowly funnel-shaped, moderately deep, the bottom occluded by prominent, ovoid, gastrostyle; ampullae close to surface but not forming raised blisters. Colony palmate arborescent without differentiated anterior and posterior faces.

Description.—The type colony is 140 mm high and 125 mm broad; a comparable one from Monterey Bay, Calif., is 270 mm broad by 180 mm high (pl. 58; U.S.N.M. no. 43275). Another colony from Monterey Bay, which is perhaps a record for size, measures 290 mm high, and 480 by 350 mm in area. Rather numerous, massive, irregular, coalesced trunks form the heavy base of the colony, from which spring roughly palmate elements subdivided (sometimes dichotomously, sometimes not) into irregular branches. There are fully 200 of the terminal blunt branchlets 5 to 8 mm in diameter. Some of the branches coalesce above the basal irregular mass of trunks. Another specimen (Monterey Bay) is 160 mm high, about 190 mm broad, and 60 to 80 mm thick. The base of the colony is solid, roughly fan-shaped, the short thick branches arising in several tiers from the margin and subdividing dichotomously.

The cyclosystems are very numerous, 0.6 to 1 mm in diameter, characteristically funnel- rather than cup-shaped, the margin indented by usually 4 to 8 *unequal* dactylotomes, which are broader at ends than next to the gastrostome. They incise the sides of gastropore deeply (pl. 58, fig. 3*b*). Margin of cyclosystem is raised slightly above the coenosteal surface as a low abrupt ridge. There is some variation in the size of dactylotomes, but their inequality is very

characteristic both of the type specimen and the Monterey Bay specimens. Occasionally two cyclosystems are merged into a larger irregular one with two gastrostyles. In *A. californica* the gastrostyle is really smaller and slenderer than in *A. venusta* but, when viewed from above, appears to be larger. A section of the cyclosystem shows that only a part of the gastrostyle of *venusta* can be seen from above, while in *californica* the entire width is exposed.

The ampullae lie just under the surface but do not form blisters. Male ampullae (as in type) are very numerous, subspherical, 0.25 to 0.4 mm in diameter, and packed between the cyclosystems in one layer, to such an extent that the dividing walls are very thin. The female ampullae are also very numerous, oblate spherical to ellipsoidal, and 0.7 to 1 mm in diameter (pl. 58, fig. 3*b*).

The coenosteum of the branches, when fractured, is rather porous, but the surface layer is firm and the surface itself has a minutely "sugary" texture. It is sometimes provided with low papilliform prominences, which may be so numerous as to be set apart only once or twice their own diameter all over the surface of the colony; or they may be nearly absent, only sparsely scattered on terminal twigs (largest colony, male); or practically absent (large colony, female). In addition there is a variable number of papilliform pores (pl. 58, fig. 3), raised orifices of canals descending into the coenosteum, often in the walls between ampullae. These are very numerous in a large female colony and are regarded as independent dactylopores.

Color variable: Coral red, light coral red, coral pink; jasper pink shading to acajou red and pompeian red, with tips of branches ochraceous-salmon paling to light ochraceous-salmon (largest colony). One branch of largest colony is dull pleroma violet (Ridgway's nomenclature).

Type.—Peabody Mus. (Yale Univ.) no. 447.

Type locality.—California.

Specimens examined.—The type, "California"; Monterey Bay, Calif., 4 colonies, one very large; Carmel Bay, Calif., 1 colony; station 3158, 12 small colonies and fragments; station 3159, fragments.

Remarks.—I have examined the type colony, of which a fragment was kindly donated for direct comparison with my material from Monterey Bay. Verrill states that the type was collected by Maj. William Rich during the war between Mexico and the United States and may have come from deep water in the Gulf of California. The Monterey Bay examples are typical and were taken in about 25 fathoms in some cases probably deeper since they were brought up on rock-cod lines.

The cyclosystems resemble those of *A. verrilli*, where, however, the dactylotomes are normally equal. In *verrilli* the ampullae form low blisters on the surface. *A. verrilli* has not been taken south of the

Sucia Islands, Wash., while *californica* has not been found north of the region of the Farallone Islands, Calif.

ALLOPORA VENUSTA Verrill

PLATE 55, FIGURE 3; PLATE 61, FIGURES 2, 2*a*

Allopora venusta VERRILL, Trans. Connecticut Acad. Arts and Sci., vol. 1, p. 517, pl. 10, fig. 9, 1868.—FISHER, Ann. Mag. Nat. Hist., ser. 10, vol. 8, p. 393, pl. 15, figs. 2, 2a, 1931.

Diagnosis.—Differs from *A. californica* in having very short dactylotomes and a shallower gastropore with rounded bottom; gastrostyle larger, enclosed in a definite style chamber, its summit encroached upon by bottom of gastropore proper.

Description.—All the specimens of this species I have examined are much smaller than those of *californica*. The type colony is 25 mm high and 50 mm broad, its expanded base attached to a water-worn stone. It rises in stout lobes or branches; some of the branches are broad and somewhat palmate or digitate; the terminal branchlets are mostly round, about 3 or 4 mm thick, with obtusely rounded tips. Several small colonies all from Cape Flattery, Wash., are about 35 mm high and 40 mm broad, with few dichotomous branches. The Monterey colony is 70 mm high, 70 mm broad, and about 30 mm thick.

The cyclosystems are subcircular, with a low, abruptly raised border, and 5 to 8, usually 6 or 7, shallow subequal, dactylotomes, much smaller and more nearly equal than those of *californica*. The central cup is shallower and of a different form (pl. 61, fig. 2*a*). These differences are not brought out by Verrill's diminutive figures. Viewed from above, the gastrostyle tip is seen through a subcircular aperture of the bottom of the cup. The border of this aperture is a ridge composed of ornate, lobate rugosities, somewhat more prominent than the fenestrated rugose skeleton of the cup itself and only clearly apparent in specimens cleaned with sodium hypochlorite solution. The entire breadth of the minutely hirsute style is not apparent from above. Diameter of cyclosystems 0.5 to 0.8 mm.

The ampullae are imbedded in the coenosteum and only occasionally produce a faint swelling of the surface. The male are subspherical or a little higher than broad and about 0.25 to 0.4 mm in diameter. The female are about 0.75 mm in diameter and conspicuously lower than wide.

A pale violet form from Cape Flattery, 40 fathoms, has usually appreciably deeper cups than the type forma. The marginal dactylopores are typical.

A southern form (Farallone Islands and Monterey Bay, rose pink in color) also has slightly deeper cups. The Monterey Bay example, in addition, has an unusually small aperture in the bottom of the cup,

so that the subacute end of the gastrostyle (which is somewhat slenderer than in the type form) is less exposed than in northern specimens.

In *venusta* the surface of the cleaned coenosteum is smooth, not minutely pitted or fenestrated, yet, owing to the underlying structure, under strong magnification it reminds one of pink sugar. The little papillae are sparse and of uncertain occurrence, and the intercalycine dactylopores are scarce, tiny, and without a raised border (which is not always present in *californica*).

Color: There are two color phases, the prevalent pink one (a dull begonia rose to alizarine pink) and a faded violet form (tourmaline to laelia pink) occurring off Cape Flattery.

Type.—In Museum of Comparative Zoology, Cambridge, Mass.

Type locality.—Neah Bay, near Cape Flattery, Wash.

Specimens examined.—The type. Also from Station 2873, 1 colony; station 2874, 24 small colonies and fragments; station 2875, 15 small colonies and fragments; station 2888, 3 colonies; station 3050, 1 colony; station 3158, 1 colony; Monterey Bay, Calif., 30 fathoms, 1 colony.

ALLOPORA PAPILLOSA Dall

PLATE 54, FIGURES 4, 4*a*; PLATE 59, FIGURE 3

Allopora papillosa DALL, Proc. Biol. Soc. Washington, vol. 2, p. 113, 1884.—FISHER, Ann. Mag. Nat. Hist., ser. 10, vol. 8, p. 391, 1931.

Diagnosis.—Colony small, thin, incrusting; cyclosystems asymmetrical, small, with funnel-shaped gastropore and 4 or 5 short, deep, unequal dactylotomes, asymmetrically distributed; a differentiated style chamber partly occluding the finely spiculate, pointed, large, subconical gastrostyle; dactylostyles well developed; coenosteum papillose, fenestrated, sugary in texture.

Description.—Owing to meagerness of material every statement concerning this species must be regarded as provisional. The entire type fragment shown in the photograph measures only 10 mm, longest dimension, and is a thin incrustation removed from a fragment of *Mytilus* shell.

The cyclosystems resemble those of *californica*, but the style is enclosed in a style chamber, the top of which, formed by outgrowths from side of gastropore, partly hides the large style, the entire width of which is not apparent when the gastropore is examined from above. In this feature the cyclosystem resembles that of *venusta*, but the gastropore is funnel-shaped, and the dactylotomes are longer, unequal, and asymmetrically arranged. The deep dactylotomes descend on side of gastropore more than halfway to tip of gastrostyle. Dactylostyles conspicuous. The largest cyclosystem (pl. 54, fig. 4) is 0.85 by 0.9 mm in diameter.

The coenosteum is scarcely thicker than depth of gastropore. Its surface is occupied by numerous, rather uniform, thimble-shaped papillae, a little broader than a dactylotome, rising about as high as the rim around cyclosystem. General surface spiculose or finely granulated. Under high magnification it appears very irregularly fenestrated and spongy, a characteristic also of the rim and interior walls of cyclosystems.

No ampullae can be detected.

Color "livid madder pink or brown" (Dall). The colony was badly in need of cleaning owing to dried organic material. After clearing with weak sodium hypochlorite the color changed to purplish vinaceous when wet; or pale laelia pink when dry (Ridgway's nomenclature).

Type.—U.S.N.M. no. 6852.

Type locality.—Coal Harbor, Unga, Shumagin Islands, Alaska.

Specimen examined.—The type.

Remarks.—The detailed figures of this species (pl. 54, figs. 4, 4*a*) have been placed next to those of *petrograpta* for convenience of comparison. Yet it seems to me that *papillosa* is possibly an offshoot of *californica* stock, while *petrograpta* is more likely related to *porphyra*.

ALLOPORA PORPHYRA (Fisher)

PLATE 59, FIGURES 1, 2; PLATE 60; PLATE 61, FIGURES 1, 1*a*; PLATE 70, FIGURES 2, 2*a*

Stylantheca porphyra FISHER, Ann. Mag. Nat. Hist., ser. 10, vol. 8, p. 395, pl. 16, figs. 5, 5*a*–5*b*; pl. 17, figs. 6, 6*a*–6*c*, 1931.

Diagnosis.—Colony encrusting, thin, reddish purple, with typically large circular or elliptical cyclosystems, having usually 8 to 12 subequal, short dactylotomes; gastropore relatively very wide and open with from 1 to 12 (ordinarily 3 to 7) robust gastrostyles, variable in size; coenosteum firm with numerous small, papilliform prominences, occasionally arranged in subparallel rows, or coalesced into interrupted meandering ridges.

Description.—The cyclosystems, which are subcircular to elliptical and relatively large, have a low, raised border indented by usually 8 to 10 dactylotomes, whose radial extent is equal to from one-fourth to one-third the diameter of the gastropore alone; rounded bottom of gastropore a little broader than the top. On the side of the cup the dactylotomes extend about 0.6 to 0.7 the distance to bottom. Diameter of cyclosystems 1 to 2 mm, usually 1.25 to 1.5 mm; depth about equal to extreme width. Occasionally two cups coalesce, but the ordinary elliptical cups are not formed by a union of two. The most characteristic feature of this species is the presence of 3 to 7 gastrostyles in both circular and elliptical cyclosystems, 3 or 4 being a common

number. In a colony from Carmel Bay the number runs higher, ranging from 5 to 12 (pl. 60). In the type colony cups with single gastrostyles are rather exceptional, but in another colony cups with one are slightly in the majority. The styles differ greatly in size, vary in form from subglobose to elongate acorn shape, and are beset with delicate, often pronged spicules. The interior of the cup is of a minutely fenestrated, spongy structure, which closely encircles the style, forming a style chamber almost filled by the style (pl. 59, fig. 1*a*). In some cases the entire breadth of style can not be seen from above on account of the encroachment of the roof of style chamber (or bottom of gastropore proper).

In aquaria the zooids expand rather readily. Their form and posture in the cyclosystem are best indicated by the figures (pl. 70, figs. 2, 2*a*). The gastrozooid has an elongate-ovoid form, the hypostome representing the broader end. The tentacles are small, blunt, 5 to 8, commonly 6, in number, and are inserted at about midheight. I have one small fragment with expanded gastrozooids on which I can find no definite tentacles. In many other fragments examined the zooids all have tentacles characteristically short with rounded tips. At the bottom of the gastrozooids the style is plainly visible whenever the mouth is widely expanded. When the gastrozooid retracts, it retires below the bottom of the cup to the slight space immediately surrounding the style—that is, into the style chamber.

The surface of the coenosteum is firm, sugary in texture under high magnification, and unevenly beset with small papillae somewhat less in diameter than a dactylopore. These papillae vary in spacing, and areas exist entirely free from them. They are sometimes merged into low ridges. In the Carmel Bay example these often form costae on the sides of certain cyclosystems rendered more prominent by the inequalities of the granite on which the colony grows (pl. 60).

The ampullae do not form rounded or blisterlike prominences, yet they may be closely packed between the cyclosystems, each cell about one-third to one-half the width of a cyclosystem. The male ampullae are subspherical, about 0.3 mm in diameter. The female ampullae are probably normally higher than broad (0.4 mm by 0.6–0.8 mm) and are sometimes so crowded that a sectional view reminds one of a miniature purple honeycomb.

Type.—U.S.N.M. no. 43018.

Type locality.—Pescadero Point, Carmel Bay, Calif. (lat. 36°33′30″ N.); on granite rock, in grotto exposed at lowest tides.

Remarks.—This species stands apart from all Alloporas and Stylasters by reason of the peculiar organization of the cyclosystem, which typically houses a small aggregation of gastrozooids, although excep-

tionally in less vigorous colonies cyclosystems with only one gastrozooid (and hence one gastrostyle) are found. Whether this condition is of generic or even subgeneric value only more knowledge of the Stylasterina will determine.

The number of tentacles of the gastrozooid varies from 5 to 8 and is commonly 6. Moseley (1879, p. 471, pls. 39, 40)[3] suggests that the presence of 12 tentacles on the gastrozooid may characterize *Allopora* and 8 *Stylaster*. But it has been shown (Hickson and England, 1905, p. 7) that the number of tentacles in *Stylaster* is variable, *S. filogranus* having 4, 5, 6, or 7.

This species has been found only at lowest tide on the exposed coast from Monterey Bay to a few miles south of Carmel Bay. The type colony, along with several others, lives in a small grottolike cavity, through which there is free circulation of water. Here they form lichenlike splashes of ruddy purple in contrast to white, scarlet, and yellow sponges, orange and bronze hydroids and bryozoans, and brown tunicates.

In 1919 the type colony alone lived in this grotto. Then it measured about 50 mm in diameter; now it measures 300 by 250 mm. From time to time sponges and tunicates that encroach upon it have been removed.

The real home of the species is probably in the dimly lighted region below lowest tide, as its occurrence in the intertidal zone is rather sporadic. Conditions at the type locality favor the upward migration of subtidal species.

ALLOPORA PETROGRAPTA, new species

PLATE 54, FIGURES 5, 5*a*; PLATE 59, FIGURE 4

Diagnosis.—Colony thin, encrusting; differing from *A. porphyra* in having smaller cyclosystems with normally only one gastrostyle; differing from *A. papillosa* in having a thicker gastrostyle, the rounded summit of which occupies the greater part of the breadth of gastropore when viewed from above; the gastropore less funnel-shaped and more tubular; surface of coenosteum with finer texture than in *papillosa*.

Description.—The material consists of five small fragments. Two of these, constituting the type, comprise the greater part of one colony (12 mm broad and 10 mm high), which covered a *Balanus*. An infant colony covers a barnacle only 6 mm broad. Colonies may reach a diameter of a foot or more, as observed by E. F. Ricketts.

The outline of cyclosystem resembles that of *papillosa* in its usual lack of symmetry, there being 3 to 8 short, deep dactylotomes with

[3] He says 6 tentacles for *Stylaster* but means 8; so stated on p. 477.

conspicuous dactylostyles. But the sides of the gastropore do not converge so much toward bottom as in *papillosa*, while the broader round-topped gastrostyle, as seen from above, is more than half as broad as the gastropore proper (i. e., cyclosystem less dactylotomes). In *papillosa* it is less than half. The gastrostyle shown in plate 54, figure 5*a*, is average; some gastrostyles are lower and broader, while a few approach more nearly the dimensions of plate 54, figure 4*a* (*papillosa*). These are rather the exception and occupy smaller gastropores, so that even here when seen from above the gastrostyle is more than half the breadth of gastropore.

A few male ampullae are visible on the fractured margin of type. They are imbedded in the coenosteum, and the walls are very rough from spicules. Two other fragments show female ampullae on the fractured margin. They are a little larger than the male and their height is a little greater than breadth (pl. 54, fig. 5*a*).

The surface of the coenosteum is appreciably finer textured than in *papillosa*, while the apparently characteristic papillae of that species are here fewer and lower—certainly of no importance as a positive character. A few dactylopores pierce the coenosteum but are not on papillae as in *californica*.

Color: The smallest colony is dull eosine pink, while the four larger fragments are dull manganese violet. E. F. Ricketts, who collected the specimens, states that larger colonies out of reach in the surf appeared to be distinctly red, rather than purple.

Type.—U.S.N.M. no. 43272.

Type locality.—Kyack Island, mouth of Sitka harbor, Alaska.

Specimens examined.—Five small fragments collected by E. F. Ricketts, of Monterey, Calif., August 5, 1932.

Remarks.—*A. petrograpta* forms reddish patches on hard rocks at lowest tide level where it is exposed to surf. Mr. Ricketts states that the habitat is the same as that of *A. porphyra*. While the colonies vary in size, the larger are of the order of a foot in diameter and may be partly exposed by receding tide. Specimens were very difficult to procure on account of surf and the rugged nature of the shore.

On the basis of available material, *A. petrograpta* is perfectly distinct from *A. papillosa*. The latter appears to be related to *A. californica*, while *petrograpta* is more like *A. porphyra*. *A. porphyra* differs radically in having much larger cyclosystems with characteristically multiple gastrostyles. But the form of the gastrostyle and the immersion of each in a tightly enclosing chamber is not fundamentally different from the structure of the single gastrostyle of *petrograpta*. Abnormally *petrograpta* may have two gastrostyles to a cyclosystem, while *porphyra* sometimes has only one.

SUMMARY OF THE REDDISH, ROSE, AND VIOLET SPECIES OF ALLOPORA

a^1. Ampullae forming definite convex blisters on the surface of colony.

b^1. Ampullae with a ridged or corrugated surface (see also *polyorchis* and *trachystoma*); gastropore narrow, cylindrical; gastrostyle small; dactylotomes 5 to 12 with clean-cut parallel sides, as long as width of gastrostome ..... **stejnegeri**

b^2. Ampullae not wrinkled or ridged but sometimes male ampullae have low central tubercle, or several.

c^1. Gastropore narrow, ordinarily cylindrical, deep, the mouth rather constricted, not obviously broader than length of dactylotomes.

d^1. Cyclosystems larger, protuberant; septa encroaching upon gastropore and decurrent as ridges on its side; gastropore deep, curved (see also *campyleca* and *trachystoma*); cyclosystems not frequently incomplete ..... **brochi**

d^2. Cyclosystems very small, not protuberant; dactylotomes about as long as diameter of gastrostome, which is not encroached upon by angles of septa; cyclosystems often incomplete or with one or more isolated dactylopores ..... **boreopacifica**

c^2. Gastrostome broader than length of dactylotome.

d^1. Colony white or buff (see also *polyorchis*); gastropore subcylindrical with a definite style chamber and robust style; male ampullae with a central low tubercle, or several ..... **moseleyana**

d^2. Colony rose or yellowish rose; gastropore broadly funnel shaped, curved, with a narrow style chamber; ampullae without tubercle ..... **scabiosa**

a^2. Ampullae forming low inconspicuous convexities on surface (see also *scabiosa*).

b^1. Gastropore subcylindrical, the gastrostome encroached upon by septa angles and narrower than length of dactylotomes, which are not expanded at outer end; dactylotomes very shallow ..... **solida**

b^2. Gastropore funnel shaped, its mouth not encroached upon by septa angles, as wide as length of the dactylotomes which are expanded at outer (dactylopore) end (compare *pacifica*) ..... **verrilli**

a^3. Ampullae sunken in coenosteum, not forming superficial blisters (see *solida* and *verrilli*).

b^1. Regularly one gastrostyle to each gastropore.

c^1. Dactylotomes not unequal in length (so that cyclosystem is more or less asymmetrical).

d^1. Gastropore cylindrical, fairly deep, without a differentiated style chamber (compare *verrilli*) ..... **pacifica**

d^2. Gastropore relatively shallow, cup-shaped, the top of the large gastrostyle partly hidden by constricted sides of the pore; large style chamber nearly filled by the style.

e^1. Colonies branched ..... **venusta**

e^2. Colonies encrusting (compare *papillosa*) ..... **petrograpta**

c^2. Dactylotomes unequal; gastropore narrowly funnel-shaped.

d^1. Colony normally large, branching; top of gastrostyle not encroached upon by outgrowths from side of gastropore; therefore no clearly differentiated style chamber ..... **californica**

d^2. Colony encrusting, thin; cyclosystems small, the gastrostyle encroached upon by outgrowths from side of gastropore, forming a style chamber.

e^1. Gastrostyle smaller, not completely filling style chamber or the passage into gastropore proper ..... **papillosa**

e^2. Gastrostyle more robust with more rounded summit; gastropore less funnel shaped and more cylindrical ... **petrograpta**

b^2. Normally more than one gastrostyle in a majority of gastropores, usually 3 to 7 (upward of 12). Colony encrusting ..... **porphyra**

Genus CRYPTOHELIA Milne Edwards and Haime

Cryptohelia Milne Edwards and Haime, Compt. Rend. Acad. Sci., vol. 29, p. 69, 1849 (type: *Cryptohelia pudica* Milne Edwards and Haime).

CRYPTOHELIA TROPHOSTEGA, new species

Plate 62, Figures 1–8; Plate 63

Diagnosis.—Flabellum massive, with robust anastomosing branches and large cyclosystems on both sides of colony; cyclosystems wide-mouthed, rather shallow, with a small ventral chamber not in direct communication with the 10 to 20 dactylopores; lid, when fully grown, nearly as large as extreme diameter of cyclosystem and containing 4 to 11 male ampullae or a single large female ampulla; very numerous nematophores on all parts of colony.

Description.—As compared with *C. pudica* Milne Edwards and Haime (1850, p. 69, pl. 3, figs. 1–1*c*) (pl. 64, fig. 1) the colony is much more massive in every respect and the cyclosystems are conspicuously larger. Plate 63 shows the anterior face of type colony where cyclosystems are more numerous than on the back. Type, 110 mm high and 150 mm wide; diameter of main trunks 17 to 20 mm; of branchlets 2 to 5 mm.

The following figure references are all to plate 62. Cyclosystems subcircular to oval, often irregular (fig. 7), the lid slightly smaller, convex, and of the same general contour (figs. 1, 7, 8). Rather frequently the distal margin of the lid fuses to the edge of cyclosystem in various ways (figs. 2, 7), leaving two lateral entrances to the cyclosystem. The more distally situated cyclosystems have a definite stalk (fig. 6) or have the margin slightly raised above the general level of branchlet; on the larger branches the margin is flush with the general surface. The number of dactylopores is quite variable, generally 10 to 20; usually in well-formed systems 16 to 20.

The relation of dactylopores to gastropore, and form of latter, are best appreciated from figures 4 and 5. The ventral chamber (*vc*) is very small, and there is no conspicuous channel leading into it from bottom of dactylopore as figured by Moseley (1879, pl. 35, fig. 7*c*) for *C. pudica* (=*C. moseleyi* Hickson and England). The diaphragm separating the upper from the lower chamber has a circular or occa-

sionally oval orifice with small accessory perforations. The margin of the orifice is usually entire but may be irregular or even deeply indented. Diameter of larger cyclosystems 2 to 3 mm; of the smaller about 1.5 mm; depth variable, usually less than extreme width of cyclosystem but more than half that width—around three-fifths to four-fifths of the width.

In an alcoholic specimen the prominent tentacular dactylozooids are bent over the retracted gastrozooid. These dactylozooids emerge from the dactylotome at a considerable distance below the margin of cyclosystem (fig. 5*d*) not nearly even with margin as figured by Moseley for *C. moseleyi* (1879, pl. 42).

The ampullae of both sexes are lodged in the swollen lid and its stem. In the male type colony there are upward of 11 (fig. 1). I have found as few as 5. In the rather small lid, marked *a* in figure 7, there were six ampullae, of which three were in the lid proper and three in the vertical portion. The swelling which indicates these stem ampullae is shown in figures 4 and 6. In the bottom of each ampulla (fig. 1) is a small natural aperture. Figure 3 shows a vertical section of a cyclosystem in which the lid has attachments on opposite sides as in figure 2.

There are two fragments of a female colony 50 by 40 mm and 45 by 30 mm. The large ampulla occupies the lid and stem, the size varying with the maturity of contents. Several ampullae examined contained a mature planula similar to that figured by Moseley (1879, pl. 42), its ectoderm crowded with elongate nematocysts. After the escape of the planulae the remains of the lid are absorbed or else sloughed off. It then regenerates from the base of stem. This is indicated by the number of cyclosystems with budding or partly developed lids. The ampulla originates in the bend of the stem. As the lid grows it enlarges, or more correctly, perhaps, the development of the embryos occasions the extension of the ampulla and hence the growth of the lid. The ampulla extends only a short distance into coenosteum at base of stem.

Thickly sprinkled all over the coenosteum are small shallow pits 0.07 to 0.11 mm in diameter, the nematophore pits. There is usually a fairly definite row of them on the margin of the lids. They are less conspicuous than in figure 7. The surface of the coenosteum under low magnification is smooth, but under high shows fine low anastomosing ridges, 0.05 to 0.08 mm in diameter.

Color of dried colony, yellowish white, which bleaches to pure white in sodium hypochlorite solution.

Type.—U.S.N.M. no. 42876.

Type locality.—Station 3480, Amukta Pass, Aleutian Islands, lat. 52°06′ N., long. 171°45′ W., 283 fathoms, black sand and rocks; bottom temperature not recorded.

Specimens examined.—The type and several small fragments from another male colony; two female fragments.

Remarks.—Although this species is in the same section of the genus as *C. pudica* Milne Edwards and Haime (not Moseley) the two are entirely different. I have specimens of *C. pudica* (pl. 64, fig. 1) taken by the *Albatross* at station 5423, Sulu Sea, 508 fathoms, gray mud and coral sand, bottom temperature 49.8° F. The colony is delicate, with longitudinally striated stems, and many of the cyclosystems are supported by relatively long slender pedicels. The cyclosystems are 1 to 1.3 mm broad, have about 15 dactylopores, and the lid stands higher above the cyclosystem than in *trophostega.* These mature lids completely cover the cyclosystem. The female ampullae are very convex, almost subhemispherical, slightly uneven. The free edge of the lid extends in front of the ampulla like the visor of a miniature jockey cap. *Nematophore pits are absent.* On this specimen of *pudica* are lids in all stages of growth, starting from small lobes on the side of cyclosystem. In *C. pudica* the cyclosystems all turn to the front of the colony. Enlargement of figures of plate 64 is twice that of plate 63.

A species I have provisionally identified as *C. japonica* (Milne Edwards and Haime) (pl. 64, figs. 2–4) can be distinguished from both *pudica* and *trophostega* by the size of cyclosystems and surface texture of coenosteum and by the small lids, which do not contain ampullae. Some cyclosystems have no lid. In others the lid begins as a lobelike outgrowth of a wider septum between two dactylotomes. The male ampullae are imbedded in the coenosteum between the cyclosystems and are evident superficially only as slight irregularities of surface. Diameter of cyclosystem 1.5 to 1.8 mm; dactylopores 10 to 20. Surface of coenosteum coarsely vermiculated but not longitudinally striated. (*Albatross* station 4890, 10 to 12 miles southwest of Goto Islands, Eastern Sea, lat. 32°26′30″ N., long. 128°36′30″ E., 135 fathoms, rocky; bottom temperature 52.3° F. Station 4924, in Colnett, or Vincennes, Strait, 30°5′ N., 130°21′20″ E., 159 fathoms, rocky; bottom temperature 55.8° F.)

Hickson and England (1905, p. 21) in discussing specimens of *C. pudica* remark that "the peculiarities of this species are its robust growth and the large size of the cyclosystems." Everything in nature is, of course, relative. As compared to *C. trophostega* the cyclosystems of *pudica* are small and its growth scarcely robust. I have inserted on plate 64 (fig. 5), enlarged twice natural size as are the other figures, a photograph of *Cryptohelia gigantea*, new species, from station 2818, Galapagos Islands, lat. 00°08′ S., long. 90°06′ W., 392 fathoms, white and black sand; bottom temperature 43.9° F. Type, U.S.N.M. no. 43273. Cyclosystems *3.5 to 5 mm* in diameter, funnel-shaped, with 20–25 long, shallow dactylotomes sloping evenly down to gastrostome proper. At this point the very thin ridges separating the

dactylotomes are bound together by a narrow lime-lattice, below which the pores communicate with the spacious ventral chamber, the walls of which are spongy and deeply fenestrated. *There is no ledge or diaphragm* separating the ventral chamber from the part above, as in *trophostega*.

The lid is occupied by a single large female ampulla which extends into stem but not below. Its dorsal wall is stout and its inner surface is spongy and fenestrated. The coenosteum is white, marked by fine, rounded longitudinal ridges. There are no nematophore pits.

This species is really robust.

Genus ERRINOPORA Fisher

Errinopora Fisher, Ann. Mag. Nat. Hist., ser. 10, vol. 8, p. 397, 1931 (type: *Errina pourtalesii* Dall).

Protoerrina Broch, Einige Stylasteriden (Hydrokorallen) der ochotskischen und japanischen See, p. 59, 1935 (type: *Protoerrina stylifera* Broch).

Diagnosis.—Resembles *Errina* (including *Labiopora*) in having a gouge-shaped projecting lip to each major dactylopore but differs in the presence of a well-developed spiculate dactylostyle; no differentiated cuplike cyclosystem, although where the pores are not crowded several dactylopores encircle a gastropore; tip of gastrostyle flush with surface or sunken in an undifferentiated depression; fewer scattered tiny dactylopores without projecting lip; coenosteum spongy reticulate superficially, compact centrally. The channel of the dactylostyle is not definitely oriented either toward the end of the branch or in the opposite direction, as in most species of *Errina*.

So far as now known, this genus is confined to the north Pacific region. The most generalized or primitive species is *E. stylifera* (Broch).

ERRINOPORA STYLIFERA (Broch)

Plate 65, Figure 1; Plate 69, Figures 3, 3*a*

Protoerrina stylifera Broch, Einige Stylasteriden (Hydrokorallen) der ochotskischen und japanischen See, p. 59, fig. 1, 1935; Untersuchungen an Stylasteriden, p. 101, fig. 32, pl. 13, fig. 40, 1936.

Diagnosis.—Colony subflabellate; branches coarse; color pale pink; dactylotomes not very prominent; gastropores deep, the apertures not sunken in concavities; gastrostyle broadly lanceolate, not reaching mouth of pore; female ampullae very numerous, superficial, large, the floor beset with numerous pronged spicules; coenosteal surface spongy.

Description.—Typical colony 70 mm high and 70 mm broad, subflabellate, with three principal branches, which divide dichotomously two or three times, the branches diminishing gradually in size and ending in rounded, sometimes slightly broadened tips. Diameter of trunk 10 by 15 mm; of terminal branches 4 or 5 mm.

The surface is covered with thin-walled, crowded, blisterlike female ampullae 1 to 1.6 mm in diameter; many are so close as to be in contact. Scattered irregularly among these, sometimes in series, are deep gastropores each with one or two associated dactylopores of full size forming a low scoop-shaped protuberance. The slit points toward a gastropore and in some instances is confluent with it but is separated by a sunken partition. Some of the gastropores have 1 to 3 smaller dactylopores (pl. 69, fig. 3) associated with them to form a primitive sort of cyclosystem. At the base of the colony, on the large trunk and branches where there are few or no ampullae, the gastropores are surrounded by 3 to 6 symmetrically placed narrow dactylotomes with only a very slight lip at the outer end (much less than in *E. pourtalesii*).

The gastropores are 0.25 to 0.35 mm in diameter and about twice as deep (pl. 69, fig. 3*a*). The style is 0.34 to 0.4 mm in length, spiculate, pointed; the tip reaches a little more than halfway to mouth of pore, while the width of the style is about two-thirds that of pore, or less in the case of unusually slender styles. Normally the gastrostome is on a level with the general surface rather than in the bottom of a concavity.

The characteristic feature of the dactylopore is that it projects much less prominently than in the other three species, even when the slit is tilted at a broad angle with the surface. Frequently the slit lies at a sharp angle, when its marginal projection or lip is slight. The dactylostyle is a long narrow cheval-de-frise of delicate spicules, about 0.1 mm long.

The female ampullae are very prominent, 1 to 1.6 mm in diameter and about one-half as deep. Many, but apparently not all, have the floor crowded with upright irregularly pronged spicules about 0.17 mm long. The larger ampullae have the roof, which is thin, somewhat flattened and without prominent protuberances. Male ampullae smaller, less prominent.

The coenosteum is hard, but the surface is rough, irregularly fenestrated, and spongy in texture, the dactylopore lip having a crystalline, sugary appearance. Here and there small roundish pores, apparently secondary dactylopores, penetrate the coenosteum.

Color of coenosteum pale pink, which is slightly intensified by immersion in sodium hypochlorite; ampullae yellowish.

Type locality.—Okhotsk Sea, lat. 56° 10′ N., long. 143° 15′ E., 182 meters; temperature at 165 meters, 0.51° C.

Specimens examined.—Station 5016, 2 fragments; station 5017, 3 fragments.

Remarks.—The second fragment from station 5016 has very few ampullae, which cause only a slight swelling of the surface, the main

portion of the cavity being sunken beneath the surface. They are about two-thirds the diameter of those of the other specimen and are probably male ampullae.

This species resembles *nanneca* more than *pourtalesii* or *zarhyncha*. It differs in the form of colony, color, and details of the pores. For instance, the dactylopore lip is lower, the gastrostyle is more robust, and the dactylotomes are arranged around the gastropore in a primitive sort of cyclosystem. Some such organization may well have preceded the specialized structure characteristic of *Stylaster*, *Allopora*, and *Cryptohelia*.

This species is known only from the Okhotsk Sea. Dr. Broch records specimens also from lat. 54° 36′ N., long. 143° 48′ E., 165–150 meters.

ERRINOPORA NANNECA, new species

PLATE 66, FIGURE 1; PLATE 67; PLATE 69, FIGURES 2, 2*a*

Diagnosis.—Colony dendritic, flabelliform, yellowish buff; gastropores extremely small (0.16 to 0.2 mm in diameter), relatively deep, with a slender sharp style reaching about halfway to aperture; dactylotomes projecting but smaller than in *pourtalesii;* when dactylopores become crowded the styliferous furrow is oriented toward end of branchlet; female ampullae relatively large, blisterlike with thin wall; coenosteum solid, the surface minutely roughened, microscopically porous.

Description.—The type colony is 130 mm high and 80 mm broad. The three main branches with their branchlets lie in the same general plane, so that the colony tends to be flabellate. The main trunk of the colony is 18 to 25 mm thick, slightly compressed beyond the base, this compression becoming more and more pronounced until the distal or top branchlets are decidedly flattened or compressed, with truncate or rounded ends. Below these flattened terminal branches, others are more nearly terete. Most of the zooids are on one face of the colony, which may be called the front. On the back the pores are found usually near the margins of the flattened branches. Even the backs of the slenderer branchlets are fairly free from pores except near the tips.

On the branchlets, the furrow of the projecting dactylopore is generally directed toward the end. On the main branches where they are less crowded (except for abundant ampullae) the furrow may be turned in any direction, depending upon the position of the associated gastropore. Where the gastropores are scattered, as on the trunk and main branches, 2 or 3 small dactylopores are associated with a gastropore, but the furrow does not always face the gastropore—it may in fact be turned directly away from it.

The gastropores are very small, 0.13 to 0.18 mm at the orifice and 0.5 to 0.7 mm deep. A few reach 0.2 mm in diameter. The gastrostyle is slender, very sharp, and in the deepest pores reaches about halfway to the orifice. The furrow of the dactylopore is about 0.1 mm broad, and the entire projecting process is 0.3 to 0.45 mm broad at the end. Along the bottom of the furrow is a cheval-de-frise of delicate spicules, the dactylostyle, which does not reach the distal end of the furrow (pl. 69, fig. 2*a*). Scattered, very small pores, one-fourth to one-fifth the diameter of the gastropores, probably represent secondary dactylopores and are entirely without projecting lip.

The female ampullae form blisterlike, dome-shaped prominences, 0.8 to 1.5 mm in diameter, crowded on the front face of the main branches, and to a less extent on the back. In dried specimens they are conspicuous by reason of their lighter color. There are commonly a number of prominences on the surface of the ampullae as indicated in plate 69, figure 2.

The coenosteum is hard and very solid, but the surface is spongy, intricately fenestrated, and minutely rough in texture, owing to very tiny, crowded, irregular, branched spicules. The surface of the distal branches is of a coarser texture than that of the trunk where the interstices are smaller and the spicules more compact.

Color of dried colony yellowish buff (capucine buff on the lighter parts to apricot buff and zinc orange on the darker; Ridgway's nomenclature).

Type.—U.S.N.M. no. 42875.

Type locality.—Station 3599, Bering Sea, lat. 52°05′ N., long. 177° 40′ E., 55 fathoms, rocky, fine sand, shells.

Specimens examined.—The type (pl. 66, fig. 1), paratype (pl. 67), and 5 colonies from station 3599. Also from station 4777, 3 colonies, fragments, and 2 very small colonies on pebble with *Allopora verrilli.*

Remarks.—The yellowish color, tiny gastropores and dactylopores, and large female ampullae are trenchant characters that separate this species from *pourtalesii*, which is light pink. In *pourtalesii* the gastropores are 0.25 to 0.35 mm in diameter and the robust style nearly fills the cavity, whereas in *nanneca* the pores are about 0.17 mm in diameter with a very slender style. The dactylostyle is relatively smaller than in *pourtalesii.*

ERRINOPORA ZARHYNCHA, new species

PLATE 68; PLATE 69, FIGURE 1

Diagnosis.—Colony branching, strongly flabelliform, the branches relatively massive, more or less compressed, a few times dichotomously divided; projections large, ordinarily 1 to 2 mm long and

0.6 to 1 mm broad at the end; gastropores 0.3 to 0.5 mm in diameter and about twice as deep; style slender; distal dactylotomes usually (but not invariably) oriented toward end of branch or sidewise toward margin; male ampullae very small, inconspicuous, about the diameter of a gastropore; coenosteum with a fenestrated, or spongy, rough surface; internally solid, fine grained.

Description.—The type colony is 140 mm high and 185 mm broad and consists of a stout trunk (20 by 15 mm thick) and massive, compressed, dichotomously divided, terminally blunt branches lying in one plane so that the general form is strongly flabellate. The proximal branches are 20 to 25 mm broad and about 15 mm thick. The trunk is devoid of pores (though there are faint scars of old ones), but all surfaces of the branches are crowded with coarse projecting dactylotomes standing singly or coalesced into groups of 2 to 8 or 10. On the front of the colony the scoop-shaped dactylotomes are about one-third to one-half longer than on the back.

On the proximal part of the main branches, the dactylotomes are not oriented in any definite direction; but distally the groove is usually turned toward the end of the branch, or sidewise toward the margin, as is indicated in the photograph. The gastropores are irregularly distributed in the deep and rather narrow spaces between the dactylotome projections; but at the base of the main branches near the trunk, where the zooids are uncrowded, 2 to 7 low dactylopores may irregularly surround a gastropore in a primitive cyclosystem.

The gastropores are unequal in size, the diameter at mouth varying from 0.3 mm to 0.5 mm, with a few as small as 0.21 mm. The majority are around 0.4 mm. The depth is a little hard to determine but is generally about twice the diameter at mouth. The gastrostyle is a fairly sharp one, rather slender, not filling the cavity. It extends rather more than halfway to orifice. The furrow of the dactylopore (i. e., the dactylotome), at the end of the projection, is about 0.5 mm deep and 0.3 mm wide. Length of projection varies according to position; the longest are about 2 mm. The dactylostyle is a very narrow, carinate cheval-de-frise of delicate, short spicules, which in the longer dactylotomes extends about half the length of the furrow and in the shorter ones about three-fourths. Scattered, very tiny pores may represent secondary dactylopores.

The ampullae (probably male) are inconspicuous and relatively very small, being simply slight swellings at the base of the dactylopore projections, the cavity subspherical with a diameter about that of a larger gastropore. The wall is very delicate—a fine, irregular grille.

The coenosteum is hard and very solid, but the surface is spongy or minutely fenestrated, with irregular trabeculae and tiny raised irregular processes. After cleaning with sodium hypochlorite solution the

thin walls of the ampullae are perforated by irregular pores forming a sort of grille work. The surface of the stem is hard, fairly smooth, not at all fenestrated.

Color of dried colony, ochraceous-buff.

Type.—U.S.N.M. no. 42874.

Type locality.—Station 3480, Amukta Pass, Aleutian Islands, lat. 52° 06′ N., long. 171° 45′ W., 283 fathoms, black sand, rocky.

Specimens examined.—The type and three fragments from same locality.

Remarks.—This species can be distinguished by the very large dactylopore projections, which are relatively gigantic when compared with those of *E. pourtalesii* and *E. nanneca*. But relative to the size of the groove the dactylostyle of *zarhyncha* is much smaller than in *pourtalesii*. It is narrower and does not extend so far toward the end of the spoutlike process. In *zarhyncha* the gastrostyle is slenderer and more tapered than in *pourtalesii* and of a coarser texture; it does not fill so much of the gastropore, or extend so far toward the orifice.

ERRINOPORA POURTALESII (Dall)

PLATE 65, FIGURE 2; PLATE 66, FIGURE 2; PLATE 70, FIGURES 1–1*a*

Errina pourtalesii DALL, Proc. Biol. Soc. Washington, vol. 2, p. 114, 1884.
Errinopora pourtalesii FISHER, Ann. Mag. Nat. Hist., ser. 10, vol. 8, p. 397, pl. 16, figs. 4–4*b*; pl. 17, figs. 7, 7*a*, 1931.

Diagnosis.—Characterized by its pink color, subterete, dichotomously dividing, pronglike branches, small female ampullae, and prominent dactylotome projections, larger than in any species except *zarhyncha*.

Description.—A nearly perfect colony was brought up on rock-cod lines off Point Sur (25 miles south of Monterey Bay), Calif., from a depth of between 50 and 90 fathoms. It rests on an irregular, deeply fenestrated base of dead hydrocoral thickly encrusted with sponges, bryozoans, serpulid tubes, barnacles, brachiopods, and solitary corals (*Paracyathus*). The horizontal dimensions of the living portion are 265 mm by 130 mm; total height 180 mm; the living portion 100 mm. There are very many subterete, round-tipped, one to four times dichotomously branched prongs arising from the very irregular, fenestrated, encrusting base, which, as above stated, rests on "dead" calcareous foundation. The main branches are 10 to 12 mm in diameter; the terminal branchlets 4 to 6 mm. Small colonies from off the Farallone Islands, Calif., have only a few branches and measure 35 to 75 mm in height.

The branches are rough from very numerous scoop-shaped projections, outgrowths of the margin of the larger dactylopores. The hollow of the scoop, which is the dactylotome, is oriented in every direction around a circle, and along its bottom is a slight ridge carry-

ing a cheval-de-frise of tiny spicules—the dactylostyle. Irregularly in depressions among the projections are the ovoid hirsute gastrostyles. Here and there are tiny secondary dactylopores without projecting lip, or with only a rudimentary one. In the latter a very tiny style can be detected.

On the basal part of the colony where there is no crowding (pl. 66, fig. 2) one can find numerous primitive cyclosystems composed of a central gastrostyle with 2 to 5 associated projecting dactylotomes oriented so that the slit and its style face toward the gastrostyle, the top of which may be in the bottom of a very shallow depression or else nearly flush with the general surface of the coenosteum. This is a more generalized condition than in *Allopora*, where the dactylopores are coordinated with the gastropore to form a circumscribed cup. The simpler arrangement suggests an ancestral stage of both genera.

In the large colony much of the space between the projecting dactylotomes is occupied by ampullae, probably female, crowded so close together that only a thin, often perforated grillelike wall separates them. The external wall is also a perforated grille. The subspherical cavity varies 1.5 to 3 times the diameter of an average gastropore. In a cleaned specimen these crowded ampullae have almost a frothy appearance (pl. 70, fig. 1*a*, a). In a small specimen from station 3159 are smaller ampullae, which are probably male (pl. 70, fig. 1*a*). These form a slight convexity, often at base of a projection, and the cavity varies in diameter from a little less to a little more than that of a gastropore.

The surface of the coenosteum is minutely fenestrated and spongy, with branched processes more irregular in the hollows than on the projections and more pronounced on the distal than on proximal parts of branches.

Color of dried colony, pink, varying from near eosine pink to rose pink of Ridgway's nomenclature. One small specimen is jasper pink.

Type.—In the United States National Museum and Museum of Comparative Zoology. "A large stone with several specimens upon it was obtained by Count Pourtalès in 1873, and is now in the Museum of Comparative Zoology." A small fragment of this, now in the National Museum, was used as the type.

Type locality.—50 to 100 fathoms about the Farallone Islands, Calif.

Specimens examined.—The type. Also from Point Sur, Calif., 50 to 90 fathoms, snagged by rock-cod fisherman of Vito Bruno's, Monterey, Calif., large colony, gift of Dr. G. Van Wagenen; station 3158, 8 small specimens; station 3159, 5 small colonies; Gulf of Georgia, A. Agassiz (no other data), 1 large colony, Museum of Comparative Zoology.

Genus DISTICHOPORA Lamarck

Distichopora Lamarck, Histoire des animaux sans vertèbres, vol. 2, p. 198, 1816 (type: *Madrepora violacea* Pallas).

DISTICHOPORA BOREALIS, new species

Plate 70, Figure 3; Plate 71; Plate 72; Plate 73

Diagnosis.—Resembling *D. sulcata* Pourtalès but differing in having the marginal sulcus about twice as broad, larger gastropores, still more prominent dactylopore projections, and much more strongly corrugated ampullae; surface of coenosteum minutely spiculated rather than uneven and glossy.

Description.—The colony branches mostly in one plane after the habit of typical *Distichopora*, but the branches are sometimes twisted or bent. At the base of the fragment from station 4781 (pl. 71, fig. 4) two of the main stems anastomose, and the neat flabellate structure is interrupted in the manner shown by the photograph.

The gastropores lie close together in a well-defined sulcus, the raised, rough borders of which are occupied by a series of tilted, slitlike dactylopores (or dactylotomes) oriented transversely or oblique-transversely to long axis of branch. Each dactylopore forms the aperture of a gouge-shaped projecting lip, as in *Errinopora*, these projections becoming more and more prominent on the distal portion of branchlets. Here the margins of branchlets in profile are strongly dentate on account of the dactylopore processes (pls. 72, 73).

The dactylotomes are about half as long as width of gastropore (varying one-third to two-thirds). Gastropores (from 0.25 to 0.425 mm in width) are spaced usually one-half to their own diameter apart. The spacing of dactylotomes is irregular, but there is frequently one on either side opposite a septum between two gastropores; and one, or occasionally two, on either side, corresponding to the gastropore. There are no dactylostyles.

The gastropores are very deep, slightly curved, and descend at a sharp angle to long axis of branch. Most of them end at center of branch, being separated from the series of opposite side only by a thin septum. The walls are beset by crowded short irregular spicules. The gastrostyle is very slender, usually long, and bristling with oblique sharp delicate spicules. The tip may be seen in a cleaned specimen by looking into the gastropore on the axis of its slant. Of sporadic occurrence on the front and back of larger stems are primitive cyclosystems consisting of a gastropore (sometimes 2 or 3 of unequal size) surrounded by upward of 10 dactylopore projections, with the dactylotomes turned toward the gastropore. These are usually on a slight convexity and are the first appearance of new branchlets. A similar structure is found on some specimens of *D. violacea* forma *coccinea* (U.S.N.M. no. 8978, Tahiti).

The male ampullae (pl. 71, fig. 3; pl. 73) are superficial, convex, with a ridged or corrugated surface. Diameter of ampulla about 0.5 mm; dorsal wall thin; inner surface compact. The female ampullae (p. 70, fig. 3; pl. 71, figs. 1, 2, 4; pl. 72) are strongly convex, the surface traversed by prominent, interrupted or continuous, often sharp ridges or crests; or the surface is irregularly corrugated with occasional tubercles. Diameter of ampulla 1 to 1.25 mm or about twice that of the male ampullae; dorsal wall thicker than in male; inner surface fenestrated, often with irregular branched spicules, which anastomose into a wide-meshed spongy superstructure on the wall proper.

The texture of the coenosteum of branchlets is well shown by plates 72 and 73. On the main branches the coenosteum is firmer, but the surface is not smooth to the touch, nor is there any of the slight gloss or "finish" that is found in *D. sulcata*. The lighter bands of the vermiculation apparent in plates 72 and 73 are due in part to the more porous structure of the surface layer and in part to microscopic spicules. These are more obvious (under high magnification) on the dactylotome projections and on the ridges traversing the ampullae (pl. 70, fig. 3).

Color of dried specimens: Cartridge buff (pl. 71, fig. 3), warm buff (pl. 71, fig. 1), capucine buff (pl. 71, fig. 4); Ridgway's nomenclature.

Type.—U.S.N.M. no. 43274.

Type locality.—Station 3480, Amukta Pass, Aleutian Islands, lat. 52° 06′ N., long. 171° 45′ W., 283 fathoms, black sand, rocky.

Specimens examined.—From the type locality, three male and three female fragments (largest, the type, pl. 71, fig. 1); from station 4781, one colony (pl. 71, fig. 4).

Remarks.—I have compared specimens with examples of *D. violacea* (Pallas) Lamarck, *D. coccinea* Gray, and *D. nitida* Verrill—color variations of one reef and shallow-water Indo-Pacific tropical species, *D. violacea*. This species does not have dactylotome projections and has a smooth, purple, violet, rose, red, or deep apricot corallum. *D. gracilis* Dana (1846, p. 704, pl. 60, figs. 4, 5–5*b*), from Tuamotu Archipelago, is very small, the pale rose corallum being only 23 mm high. The gastropores (0.1 mm to 0.12 mm) are one-fourth to one-third the diameter of the average pores of *borealis*. They open in a shallow sulcus, and the dactylotomes have a slightly elevated lip. The relatively broad and low female ampullae sometimes occupy the entire breadth of a branch (pl. 75) and are not corrugated but are covered like the rest of corallum with microscopic convexities or bosses. *D. rosea* Kent (1871), from the east coast of Australia, is probably the same species. As Dana's figure of the type is very small, a photograph, enlarged five times, is given (pl. 75). Type of *D. gracilis* Dana is Mus. Comp. Zool. no. 5507.

Of the species described by Pourtalès from the West Indian region, *sulcata*, *foliacea*, *cervina*, *barbadensis*, and *contorta*, the north Pacific species shows resemblance only to *D. sulcata* (see pl. 74). In this species the dactylotomes are on projections that on the distal parts of branches approach the prominence of those of *borealis*, but when specimens are compared the gastropores of *borealis* are quite evidently at least 50 percent (sometimes 100 percent) wider than those of *sulcata* and the marginal sulcus, including the limiting dactylotome projections, about twice as broad as that of *sulcata*. The ridges that roughen the surface of the ampullae of *sulcata* are smaller, more numerous, rounded, less porous, with a surface polish and without the microscopic superficial spicules of *borealis*.

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EXPLANATION OF PLATES

The drawings of details were made by the writer. The photographs were made in the photographic laboratory of the United States National Museum, with exception of plates 43, 65, 66, and 68 by G. E. MacGinitie and plates 58 and 60 by Beauford B. Fisher.

Plate 34

Allopora campyleca: 1, Portion of branchlet of male colony showing two cyclosystems and associated ampullae, × 20; 1*a*, type, longisection of a cyclosystem from side of rather small branch that necessitates the sharp curvature of gastropore, × 20, gastrostyle 0.68 mm; 1*b*, a cyclosystem from main stem of type, with three male ampullae (two opened), × 20; 1*c*, type, three dactylotomes, × 60, showing relatively small pores and small dactylostyle spicules; 1*d*, branchlet of female colony, showing cyclosystems and associated female ampullae, the lowermost sectioned, × 20, longest diameter of cyclosystem 1.2 mm; 1*e*, type, style and rudimentary style chamber characteristic of male colonies, × 30, gastrostyle 0.68 mm; 1*f*, style characteristic of female colonies, × 30, style 0.5 mm; 1*g*, longisection of a cyclosystem of female colony, × 20.

Plate 35

1–1*d*, *Allopora polyorchis:* 1, Type, a cyclosystem from the posterior face of a larger stem, × 20, cyclosystem 0.93 by 1.1 mm, three male ampullae; 1*a*, × 60, section of a style chamber viewed from above as well as from side, so that the style is considerably foreshortened, spicules shown projecting downward from gastropore wall; 1*b*, × 20, cyclosystem and two female ampullae of specimen mentioned in text; 1*c*, type, × 20, lateral face of a branchlet showing three irregular confluent cyclosystems and an independent system with the more robust gastrostyles often found in irregular systems, male ampullae above on front of colony, those below on the back; 1*d*, type, × 20, section of a rather deep cyclosystem with also on left a section of a dactylopore.

2–2*c*, *Stylaster cancellatus:* 2, Type, × 20, lateral face of a small twig showing five cyclosystems and female ampullae on front and back of twig, an ampulla opened on left, and end of branch at right; 2*a*, male specimen, × 20, a shallow cyclosystem viewed in section, with two dactylopores in section; 2*b*, male specimen, × 20, the terminal deeper gastropore of a small twig; 2*c*, male specimen, × 10, lateral view of a fairly straight branchlet of the twig-net showing three cyclosystems and male ampullae, the gastropore set obliquely as in 2*a* (note that this figure is half magnification of others).

Plate 36

Allopora campyleca: 1, Type, portion of male colony, front view; 2, fragment of female colony, back view showing ampullae. Natural size.

Plate 37

Allopora polyorchis: 1, Front view of type colony, male, 390 mm wide and 278 mm high; 2, tip of a terminal branchlet enlarged to show characteristic distortion of cyclosystems (this is possibly from a different colony).

PLATE 38

Allopora polyorchis: 1, Branchlet from type (pl. 37, fig. 1, arrow) showing abundance of male ampullae and their distribution, front view, × 4¾; 2, terminal twigs from same fragment as pl. 37, fig. 2 (note male ampullae), × 5.

PLATE 39

Stylaster cancellatus: Front view of central portion of type fragment showing orientation of cyclosystems on anastomosing branchlets and the characteristic female ampullae, × 5.

PLATE 40

Stylaster cancellatus: 1, Paratype, front of fragment of male colony, natural size; 2, back of same colony, × 5, this enlargement representing the obverse of the lower left quadrant of fig. 1; the heaviest branch (arrow) is the ascending central branch of fig. 1.

PLATE 41

1–1*d*, *Allopora campyleca paragea:* 1, Type, one of the larger cyclosystems, with two male ampullae, from a small branch, × 30; 1*a*, a branchlet showing ordinary cyclosystems, × 20, to agree with magnifications of figs. 2, 2*c*, and 2*d*; 1*b*, section of a small cyclosystem but not showing maximum curvature of pore, × 30, style 0.5 mm long, *dp*=dactylopores, that on right is independent of a cyclosystem, section of male ampulla; 1*c*, style and style chamber of a larger cyclosystem, × 30, showing maximum differentiation of style chamber; 1*d*, three dactylopores and gastrostome, × 60, showing the short dactylotomes and maximum development of dactylostyles.

2–2*e*, *Allopora campyleca tylota:* 2, Type, two of the peculiar large cyclosystems and associated female ampullae, the lowermost with roof removed to show fenestrated wall, × 20, cyclosystem 1.5 mm in diameter; 2*a*, style and style chamber of a cyclosystem from branchlet of male colony, × 30, showing only moderate development of spicules on wall of style chamber; 2*b*, view looking into gastropore from just above tip of style, showing the style chamber and the spiniform outgrowths from its wall (*cf.* fig. 3), × 60, the outer line being the boundary of gastropore, here shown in cross section; 2*c*, a cyclosystem at tip of a lateral branchlet of largest fragment (male colony), × 20; 2*d*, one of the small cyclosystems from a peripheral branchlet and two male ampullae in profile, ×20; 2*e*, section of a cyclosystem, gastropore 1.85 mm deep, style 0.59 mm long, × 20; this view shows the deep-cut dactylotomes for comparison with those of *S. elassotomus*.

3, *Stylaster elassotomus:* Type, cross section of gastropore just above end of style showing spiculate outgrowths from wall of style chamber, × 60 (*cf.* fig. 2*b*).

PLATE 42

1–1*c*, *Stylaster elassotomus:* 1, Type, a cyclosystem viewed directly from above showing the short dactylotomes and the flaring gastrostome of the larger systems, × 20; 1*a*, a portion of the above enlarged, × 60; 1*b*, longisection of gastropore, × 20, gastrostyle 0.45–0.5 mm long (see pl. 41, fig. 3) (the shallow dactylotomes are shown at top); 1*c*, branchlet with two cyclosystems and associated male ampullae, × 20.

2–2*b*, *Allopora stejnegeri:* 2, Type, a large cyclosystem from a main stem, × 20; 2*a*, two female ampullae and two small cyclosystems from branch, × 20; 2*b*, section of cyclosystem and two ampullae, × 20, the right ampullae being the normal female and the left the small sort mentioned in text.

3–3*d*, *Allopora brochi:* 3, Type, × 60, portion of a cyclosystem showing details of four dactylotomes; 3*a*, type, × 20, a full-sized cyclosystem and two female ampullae; 3*b*, type, × 20, section of a cyclosystem and two ampullae; 3*c*, type, × 20, a gastrostyle, showing also spicules on wall of style chamber; 3*d*, type, × 20, one of the small gastrostyles mentioned in text.

PLATE 43

Allopora campyleca paragea: Front view of type colony, natural size.

PLATE 44

Allopora brochi: 1, Branch of type colony, × 5; 2, type colony, about natural size, taken 90° to left of viewpoint of fig. 1.

PLATE 45

1, *Allopora brochi:* Type, slightly enlarged.
2, *Allopora campyleca trachystoma:* Front of type (female), natural size.

PLATE 46

Allopora campyleca trachystoma: 1, Front view of a fragment of male colony, natural size; 2, enlargement of right center of fig. 1, × 5.

PLATE 47

Stylaster gemmascens alaskanus: 1, Front view of a male colony, × 2; 2, enlargement of distal branchlets of fig. 1, × 5; 3, end of a female colony showing flattened branchlets, spiny outgrowths, and two ampullae, × 5 (this is the left distal branch of pl. 48, fig. 1).

PLATE 48

Stylaster gemmascens alaskanus: 1, Front view of branch of female colony, paratype, × 2 (see pl. 47, fig. 3); 2, front view of portion of type fragment, male, × 5.

PLATE 49

1, *Stylaster elassotomus:* Type, front view, × 1¾.
2, *Allopora moseleyana:* Female colony, from station 3480, front view, × 2.

PLATE 50

Allopora moseleyana: Fragment of a female colony (not of pl. 49, fig. 2), from station 3480, × 5.

PLATE 51

Allopora moseleyana: Type, male colony, from station 4781.

PLATE 52

Allopora moseleyana forma *leptostyla:* 1, Fragment of male colony showing ampullae, front view, × 2; 2, most of type colony, front view, ×1⅞; 3, fragment of female colony, front view, × 5.

PLATE 53

1–1*b*, *Allopora moseleyana:* 1, Two cyclosystems of the type, × 30, extreme diameter of cyclosystem including dactylopores 0.85–0.9 mm, diameter of style 0.25 mm, on left tubercles of coenosteum (a, ampulla; p, coenosteal pore); 1*a*, × 30, sectioned cyclosystem with robust style 0.47 mm long, the ventral or bottom chamber of the gastropore shown darker; 1*b*, × 30, sectioned cyclosystem showing also longitudinal section of dactylopores, style 0.6 mm long and ventral chamber of gastropore large; above the rim of cyclosystem is another intended to show the normal variation in depth of

cup, the bottom being the same for both (a, sectioned male ampulla *in situ*, 0.425 mm in diameter, showing laminated inner surface).

2–2*b*, *Allopora norvegica pacifica:* 2, A cyclosystem, × 30, extreme diameter 0.8–0.85 mm, tip of gastrostyle seen in profile owing to curvature of pore; 2*a*, × 30, slender style of specimen mentioned in text; 2*b*, × 30, sectioned cyclosystem from male fragment with sectioned ampulla *in situ* (a), depth of gastropore 1.2 mm, length of style 0.6 mm.

3–3*b*, *Allopora boreopacifica:* 3, Sectioned cyclosystem, × 30, showing on left a sectioned dactylopore and an isolated dactylopore; 3*a*, portion of branchlet bearing female ampullae, × 30, uppermost cyclosystem 0.74 mm in diameter; 3*b*, × 30, a sectioned female ampulla from same branchlet as fig. 3*a*.

PLATE 54

1–1*b*, *Allopora campyleca trachystoma:* 1, Type, longisection of a cyclosystem, × 20; 1*a*, several female ampullae and a cyclosystem, × 20; 1*b*, smaller cyclosystem showing three outgrowths characteristic of smaller branchlets, from specimen figured on pl. 46, × 20.

2, *Stylaster gemmascens alaskanus:* Three ampullae, probably male (indicated by arrow, pl. 47, fig. 2), seen somewhat more in profile; diameter of ampulla about 0.75 mm; × 20.

3, *Allopora verrilli:* Cyclosystem of specimen from station 4777 figured on pl. 57, fig. 2, × 30; one dactylotome is imperfect.

4, 4*a*, *Allopora papillosa:* 4, Largest cyclosystem of type specimen, × 30; 4*a*, section of a cyclosystem showing characteristic gastrostyle in style chamber, × 30.

5, 5*a*, *Allopora petrograpta:* 5, An unusually symmetrical cyclosystem showing large gastrostyle (some gastrostyles are smaller and some relatively larger than this), × 30; 5*a*, sectional view showing two female ampullae and a smaller cyclosystem with characteristic style, × 30.

PLATE 55

1, *Allopora norvegica pacifica:* Front view, × 2, station 5016.

2, *Allopora boreopacifica:* Back of colony, natural size, station 5016.

3, *Allopora venusta:* Female from station 2875, front view, × 2.

PLATE 56

Allopora stejnegeri, type: 1, Portion of right branch of fig. 2, × 4¾; 2, major portion of colony (base omitted), × 2.

PLATE 57

Allopora verrilli: 1, Male colony from Sucia Islands, Wash., × 3; 2, smaller of two colonies from station 4777, female, × 4½ (the back of colony has nearly as many cyclosystems; in the other colony there is no differentiated front); 3, type specimen, × 2, somewhat beach worn.

PLATE 58

Allopora californica: Small portion of a large colony from Monterey Bay, Calif., mentioned in text; U.S.N.M. no. 43275; × 2.

PLATE 59

1, 2, *Allopora porphyra:* 1, Part of type colony, × 6; 2, another fragment of type colony, × 3.

3, *Allopora papillosa:* Type, × 6.

4, *Allopora petrograpta:* Part of type, × 6.

PLATE 60

Allopora porphyra, alcoholic specimen from Carmel Bay, Calif. (tissue considerably smooths the surface and partly obscures the calcareous papillae; a fragment of this colony is U.S.N.M. no. 43277): 1, Enlarged slightly over twice natural size; 2, a portion near center of fig. 1, × 4.

PLATE 61

1, 1*a*, *Allopora porphyra:* 1, A typical cyclosystem with four gastrostyles viewed directly from above, × 30; 1*a*, a section of a cyclosystem showing two gastrostyles and four dactylostyles. The dotted line crossing the gastrostyles indicates the bottom of the cup; the lower, dash, line is the bottom of the colony, which was here very thin; on the right an entire dactylopore is shown in section, × 30.

2, 2*a*, *Allopora venusta:* 2, A cyclosystem from above, specimen from off Cape Flattery, × 30; 2*a*, section of a cyclosystem for comparison with fig. 3*b*, × 30.

3–3*b*, *Allopora californica:* 3, Three cyclosystems of a specimen from Monterey Bay, × 30; 3*a*, a cyclosystem of the type, × 30; 3*b*, section of a cyclosystem, specimen from Monterey Bay, × 30; on either side are portions of female ampullae.

PLATE 62

Cryptohelia trophostega: 1, A lid with dorsal wall removed to show the contained ampullae, the circular apertures of which are in the lower wall of each chamber and therefore pierce the lower wall of the lid directly over the gastropore, × 15; 2, a cyclosystem viewed from the side, showing a lid with two points of attachment, the spots indicating nematophore pits, × 15; 3, a section of a cyclosystem having a lid with two points of attachment, three ampullae (a) shown in section and at the bottom of the gastropore the very small ventral chamber (vc), × 5; 4, a cyclosystem viewed directly from above after removal of the lid in the stem of which are parts of three ampullae (a) (in the center of the gastropore is the round aperture leading to ventral chamber), × 15; 5, half of a cyclosystem sectioned in the plane x–x, fig. 4, but of a smaller cyclosystem; above are the dactylotomes, which do not communicate directly with the ventral chamber (vc), × 15; 6, a small cyclosystem at end of a branchlet, showing nematophore pits, × 15; 7, a portion of the main stem in a distal part of the colony showing variations in form of cyclosystems and the nematophore pits, × 5 (the pits are not so conspicuous as it is necessary to make them in the drawing; a, a lid with six ampullae mentioned in text); 8, a view of a fairly large cyclosystem from above with a lid in place, width of lid 2.8 mm, × 15.

PLATE 63

Cryptohelia trophostega: Type, anterior face, natural size.

PLATE 64

1. *Cryptohelia pudica* Milne Edwards and Haime (but not of Moseley): Specimen from Sulu Sea, 508 fathoms, × 2.

2–4, *Cryptohelia japonica* (Milne Edwards and Haime): 2, 3, Specimens from station 4924, Colnett or Vincennes Strait, 159 fathoms; 4, from station 4890, Eastern China Sea, 135 fathoms. × 2.

5, *Cryptohelia gigantea:* Type, from station 2818, Galapagos Islands, 392 fathoms, × 2.

PLATE 65

1, *Errinopora stylifera:* Front view, slightly enlarged, station 5016.
2, *Errinopora pourtalesii:* Three branches of small colony from station 3159 (virtually the type locality), × 3.

PLATE 66

1, *Errinopora nanneca:* Type, front view, × 1.4.
2, *Errinopora pourtalesii:* Main stem of small colony (pl. 65, fig. 2) showing primitive cyclosystems referred to in text.

PLATE 67

Errinopora nanneca: Front view of paratype from station 3599, × 1.3.

PLATE 68

Errinopora zarhyncha: Front view of type, slightly reduced.

PLATE 69

1, *Errinopora zarhyncha:* A group of gastropores and dactylopores, × 15.
2, 2*a*, *Errinopora nanneca:* Three ampullae and neighboring dactylopores and gastropores, × 15; 2*a*, two gastropores and three dactylopores, × 30.
3, 3*a*, *Errinopora stylifera:* 3, Portion of surface of terminal branch showing characteristic arrangement of gastropores and dactylopores of several sizes (the smoother swellings are ampullae), × 15; 3*a*, detail of a gastropore (in section) and, above, of several dactylopores (surface view), × 30.

PLATE 70

1, 1*a*, *Errinopora pourtalesii:* 1, Tip of a branchlet of specimen from Point Sur, Calif., showing the lipped dactylopores, dactylostyles, scattered circular gastrostyles, and female ampullae (a, a, a) with perforated wall (the small black spots are secondary dactylopores), × 15; 1*a*, from station 3159; above are two dactylopores, one showing style; below are two gastrostyles; two male ampullae, the thin wall of which has been removed; × 30.
2, 2*a*, *Allopora porphyra:* 2, A cyclosystem drawn from life showing a partly expanded gastrozooid, with eight tentacles, and contracted dactylozooids; 2*a*, a cyclosystem drawn from life showing four gastrozooids, with five and six tentacles, and encircling them the mostly retracted dactylozooids, × 30.
3, *Distichopora borealis:* Type, detail of a terminal branch showing female ampullae, dactylopores, and gastropores, × 20.

PLATE 71

Distichopora borealis: 1, Type, female, from station 3480, × 1⅓; 2, another female fragment from type locality, × 1⅓; 3, a male fragment from type locality, × 1⅓; 4, specimen from station 4781, female, natural size.

PLATE 72

Distichopora borealis: Same specimen as pl. 71, fig. 2, enlarged five times to show texture of surface, female ampullae, and dactylotome projections along border of branches.

PLATE 73

Distichopora borealis: Male specimen from station 3480, × 5.

PLATE 74

Distichopora sulcata Pourtalès: Specimen from station 2354, off Arrowsmith Bank, Yucatan, lat. 20°59′30″ N., long. 86° 23′W., 130 fathoms, natural size.

PLATE 75

Distichopora gracilis Dana: Type, Mus. Comp. Zool. no. 5507, from Tuamotu Archipelago, U. S. Exploring Expedition, × 5.

PLATE 76

A comparison of the cyclosystems of five species of *Allopora*, enlarged approximately 30 times; for each species a surface view and a longitudinal section through gastropore and two dactylopores (*d*) are given to show form of gastropore and gastrostyle (*g*). The dactylotomes (*d*) are in sagittal section.

1, 2, *Allopora solida* (Broch): Cotype.

3, 4, *Allopora norvegica pacifica* (Broch): Figure 3 is from one of Dr. Broch's white specimens on which the cyclosystems are usually circular. The gastropore is curved so that the tip of the gastrostyle, in profile, is seen on the right side. Figure 4 is from one of Dr. Broch's rose specimens. In both of these the cyclosystems are larger than in examples from stations 5016 and 5017 (see pl. 53, fig. 2).

5, 6, *Allopora verrilli* Dall: 5, Specimen from Sucia Islands, Wash.; 6, from station 4777.

7, 8, *Allopora scabiosa* (Broch): Cotype. Figure 7 represents a large cyclosystem with a bent or curved gastropore, the sides of which are as steep as in figure 8. The ventral portion of the gastropore surrounding the style, which might reasonably be interpreted as a style chamber (cf. p. 515), is often not so sharply differentiated from the portion above. In such cases the gastropore is wider opposite the tip of style. In the engraving the roughness of the style-chamber wall is much overemphasized.

9–11, *Allopora boreopacifica* (Broch): Okhotsk Sea form, station 5016. Figure 9 is one of the larger systems. The smallest are about half this diameter, and may have one, two, or three dactylotomes only.

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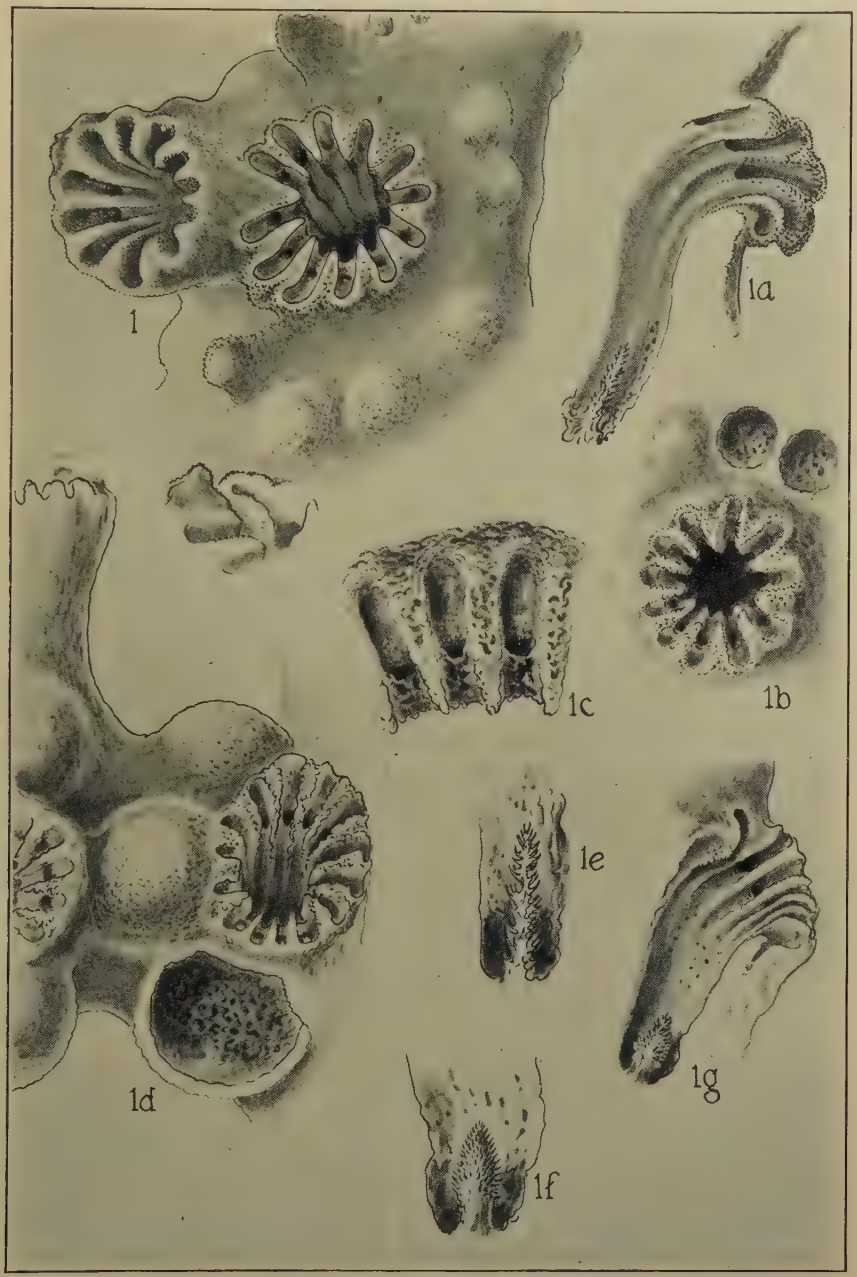
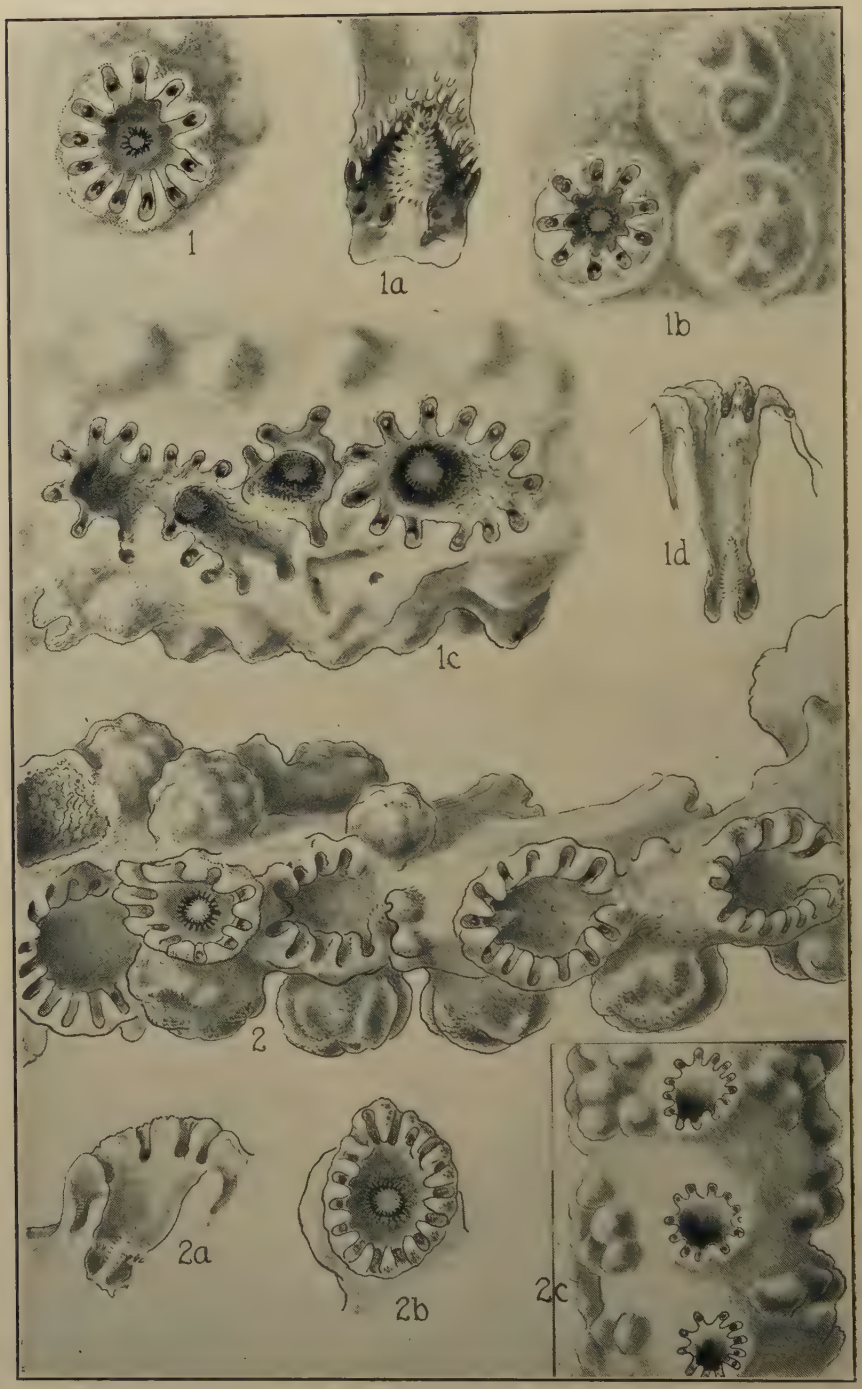


ALLOPORA CAMPYLECA.

FOR EXPLANATION OF PLATE SEE PAGE 548



ALLOPORA POLYORCHIS (1) AND STYLASTER CANCELLATUS (2).

FOR EXPLANATION OF PLATE SEE PAGE 548.

ALLOPORA CAMPYLECA.

FOR EXPLANATION OF PLATE SEE PAGE 548.

ALLOPORA POLYORCHIS.

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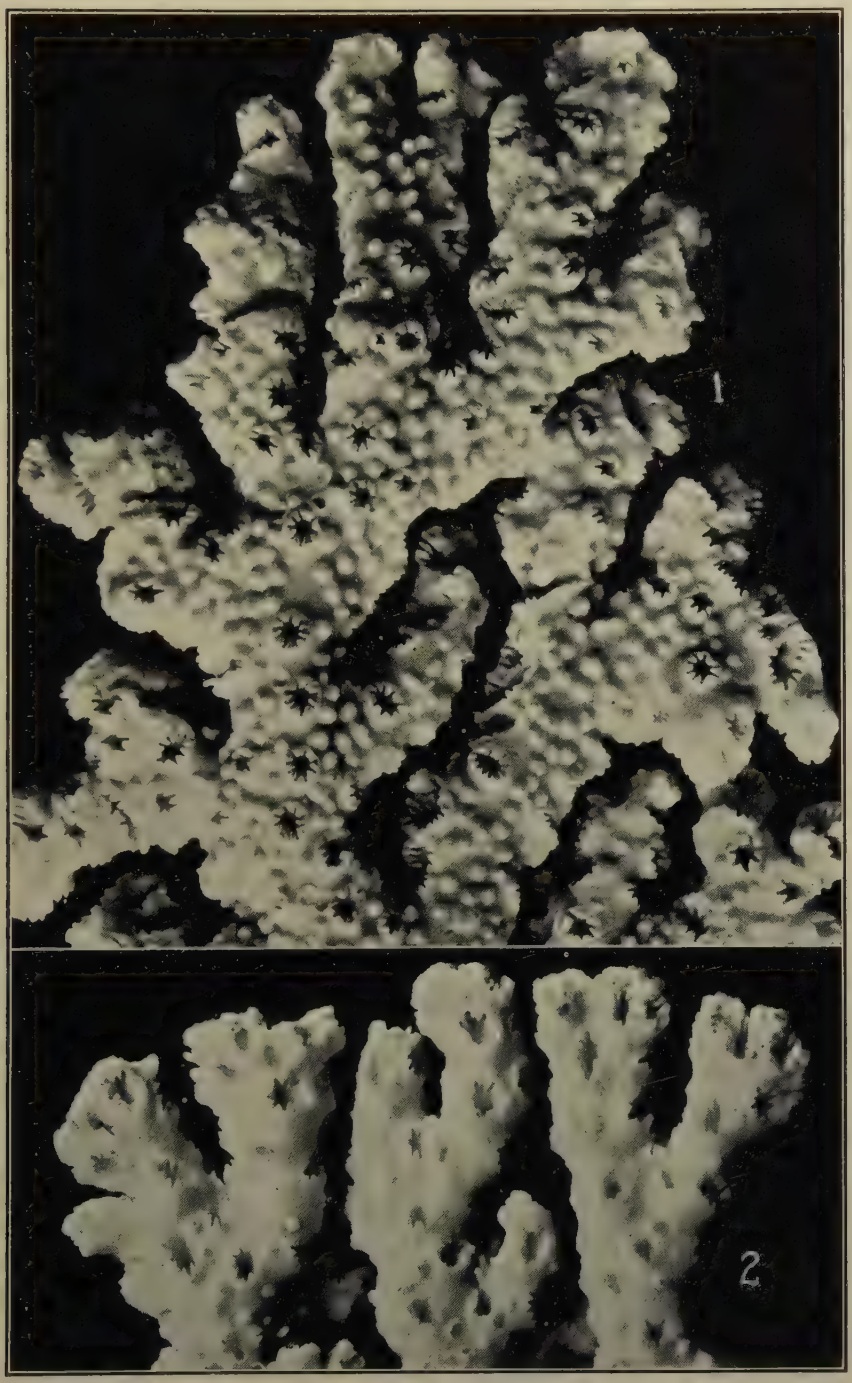

ALLOPORA POLYORCHIS.

FOR EXPLANATION OF PLATE SEE PAGE 549.

STYLASTER CANCELLATUS.

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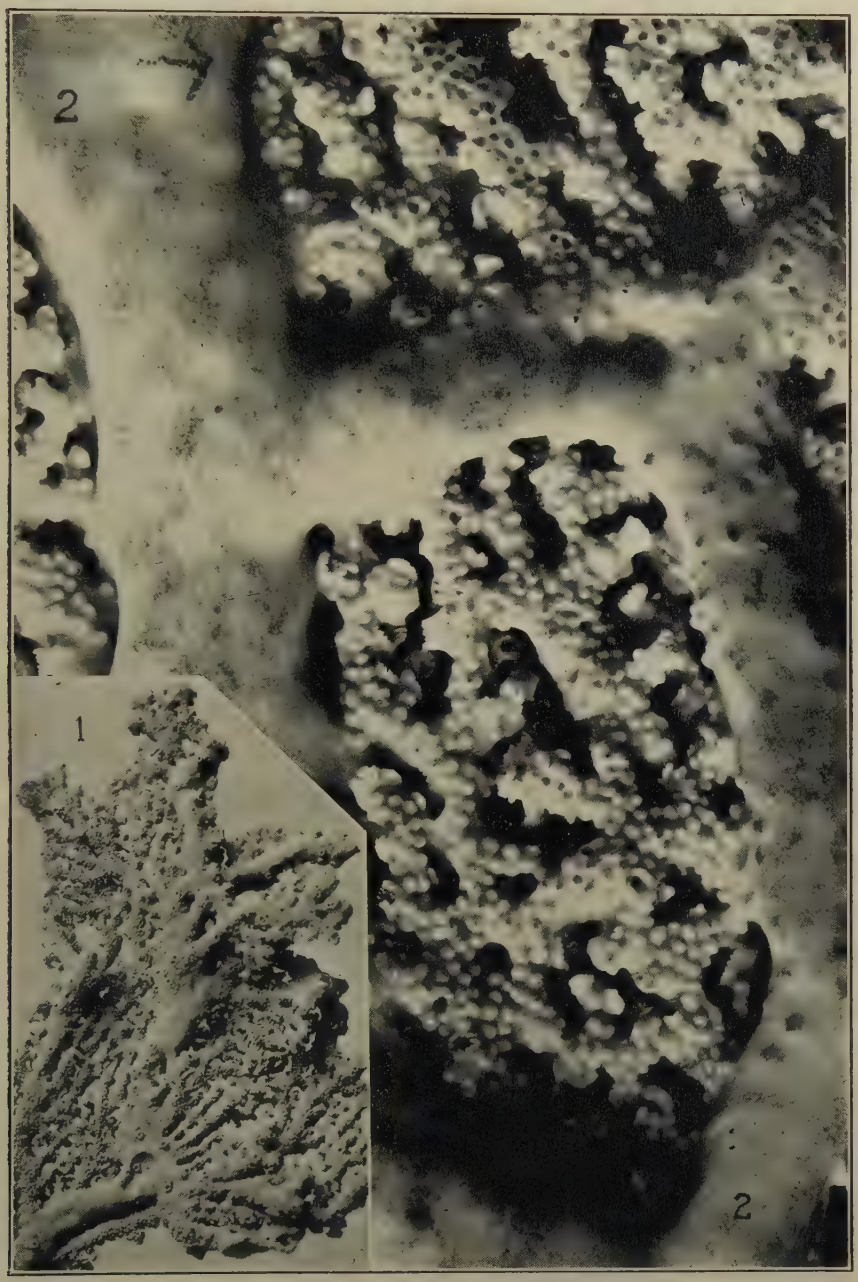

STYLASTER CANCELLATUS.

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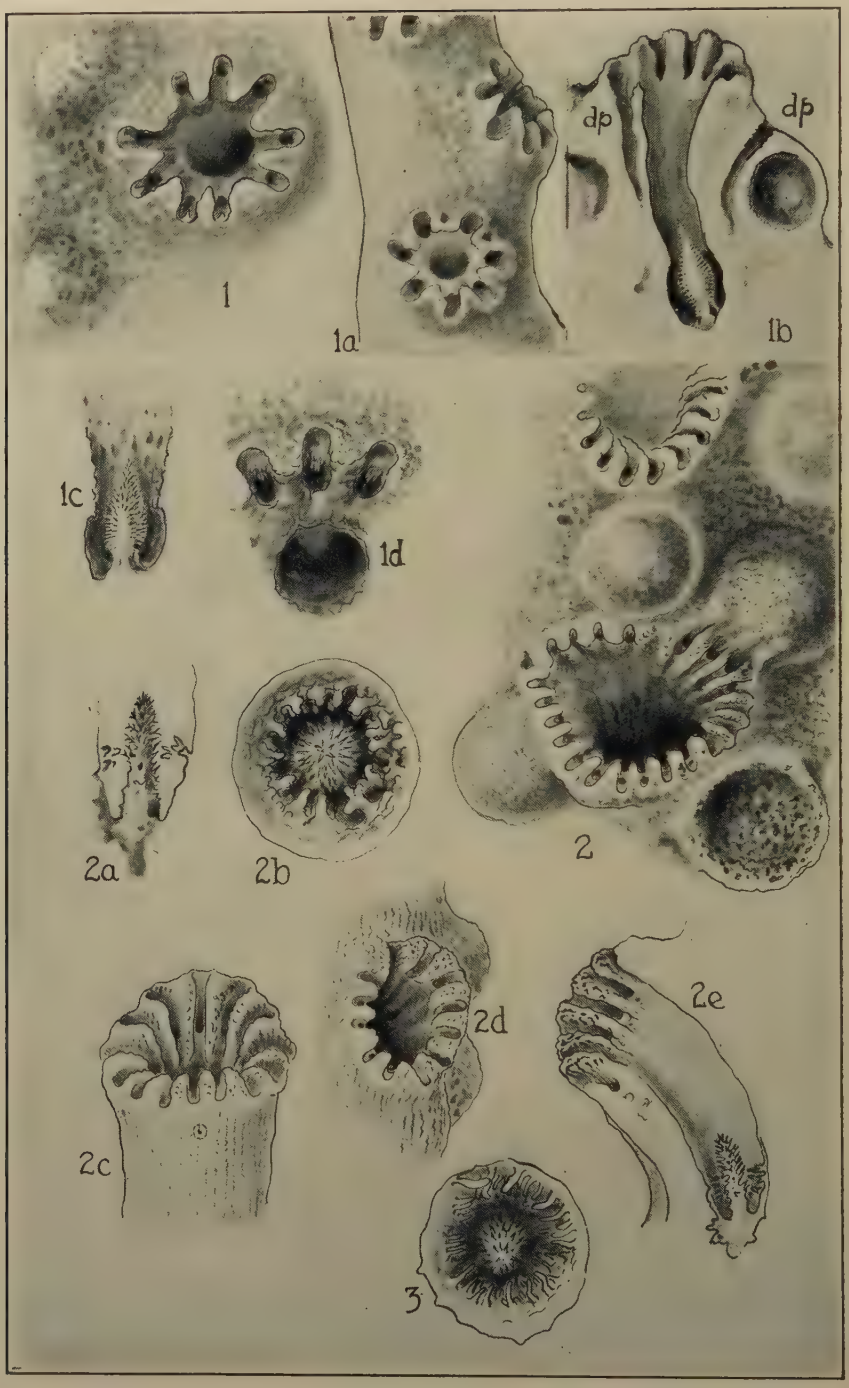

ALLOPORA CAMPYLECA PARAGEA (1), A. C. TYLOTA (2), AND STYLASTER ELASSOTOMUS (3).

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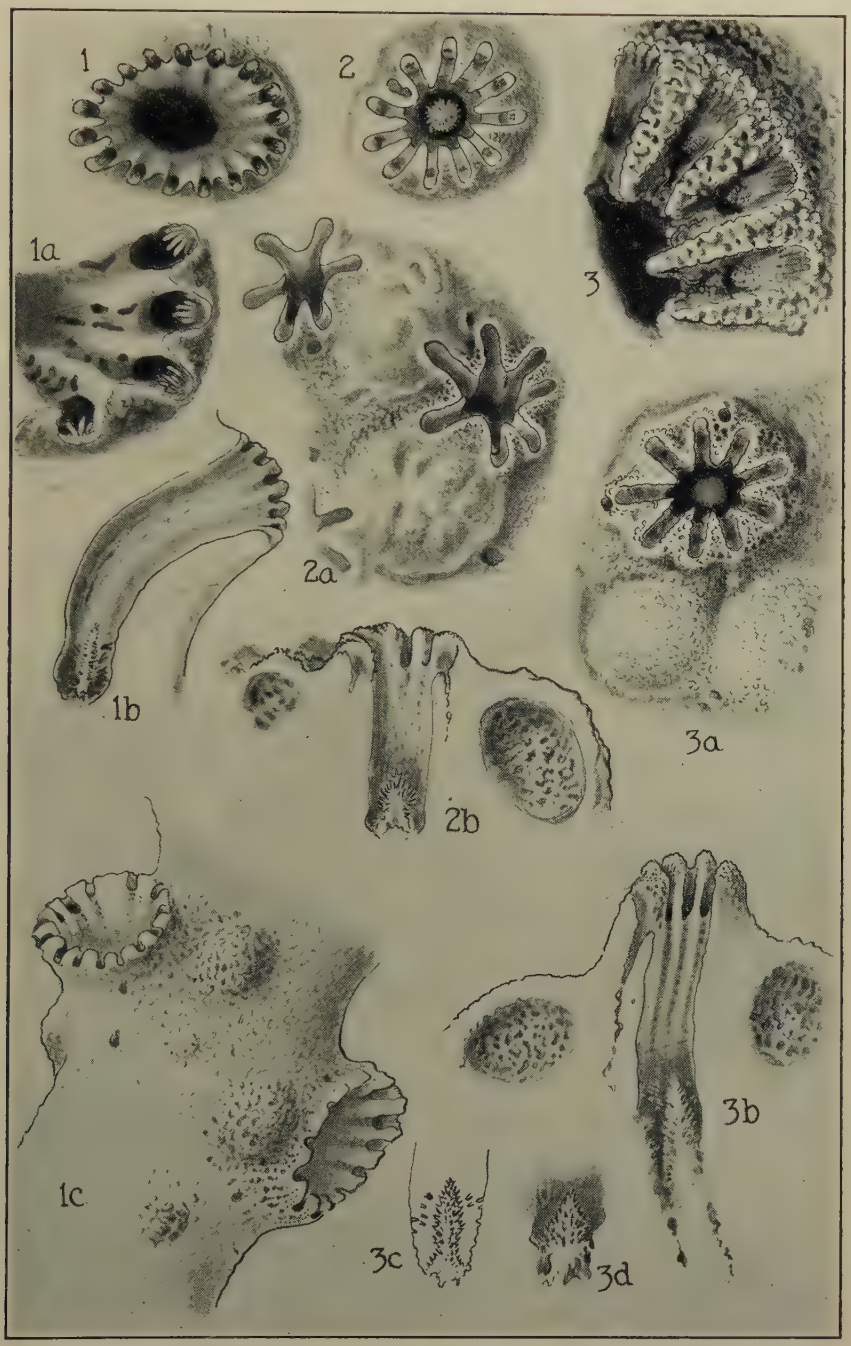


STYLASTER ELASSOTOMUS (1), ALLOPORA STEJNEGERI (2), AND A. BROCHI (3).

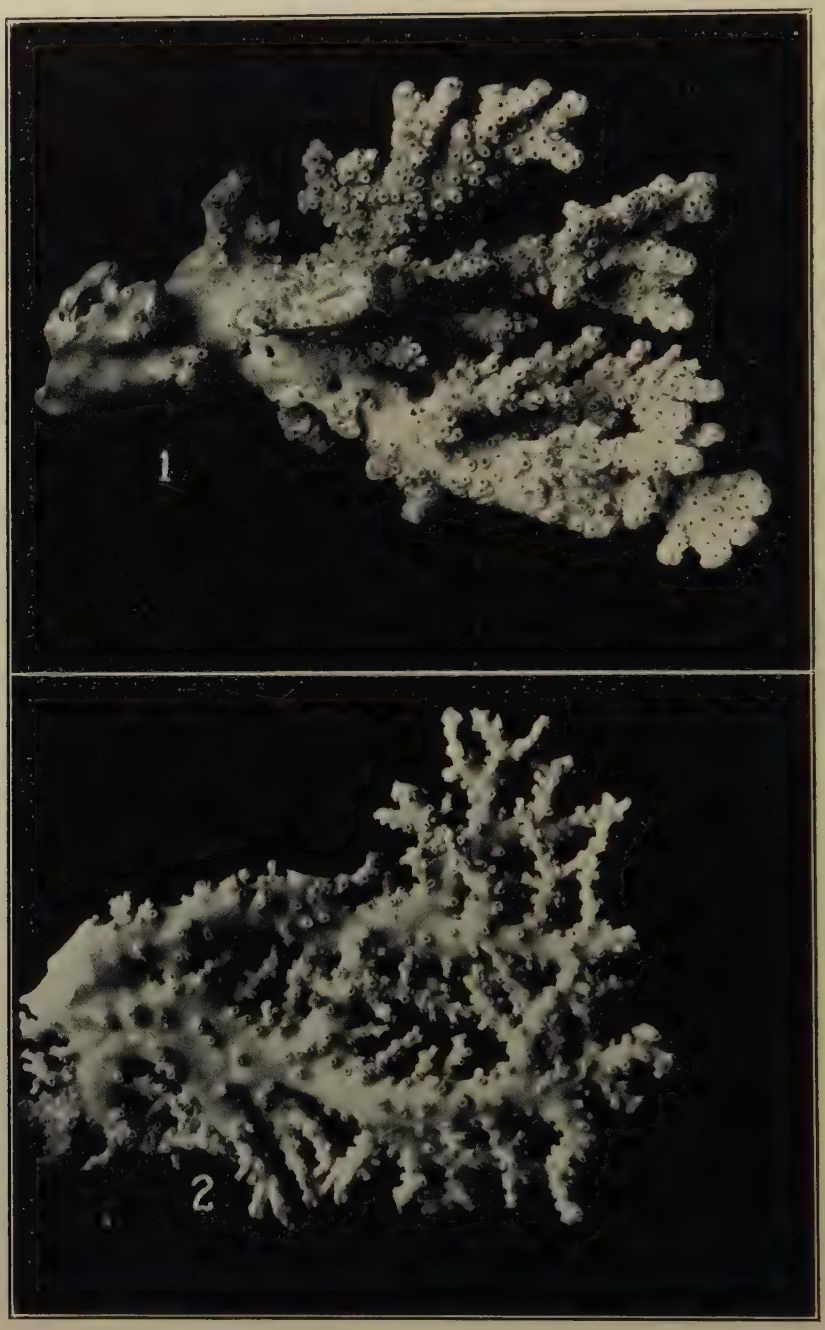
FOR EXPLANATION OF PLATE SEE PAGES 549-550.

ALLOPORA CAMPYLECA PARAGEA.

FOR EXPLANATION OF PLATE SEE PAGE 550.

ALLOPORA BROCHI.

FOR EXPLANATION OF PLATE SEE PAGE 550.



ALLOPORA BROCHI (1) AND A. CAMPYLECA TRACHYSTOMA (2).

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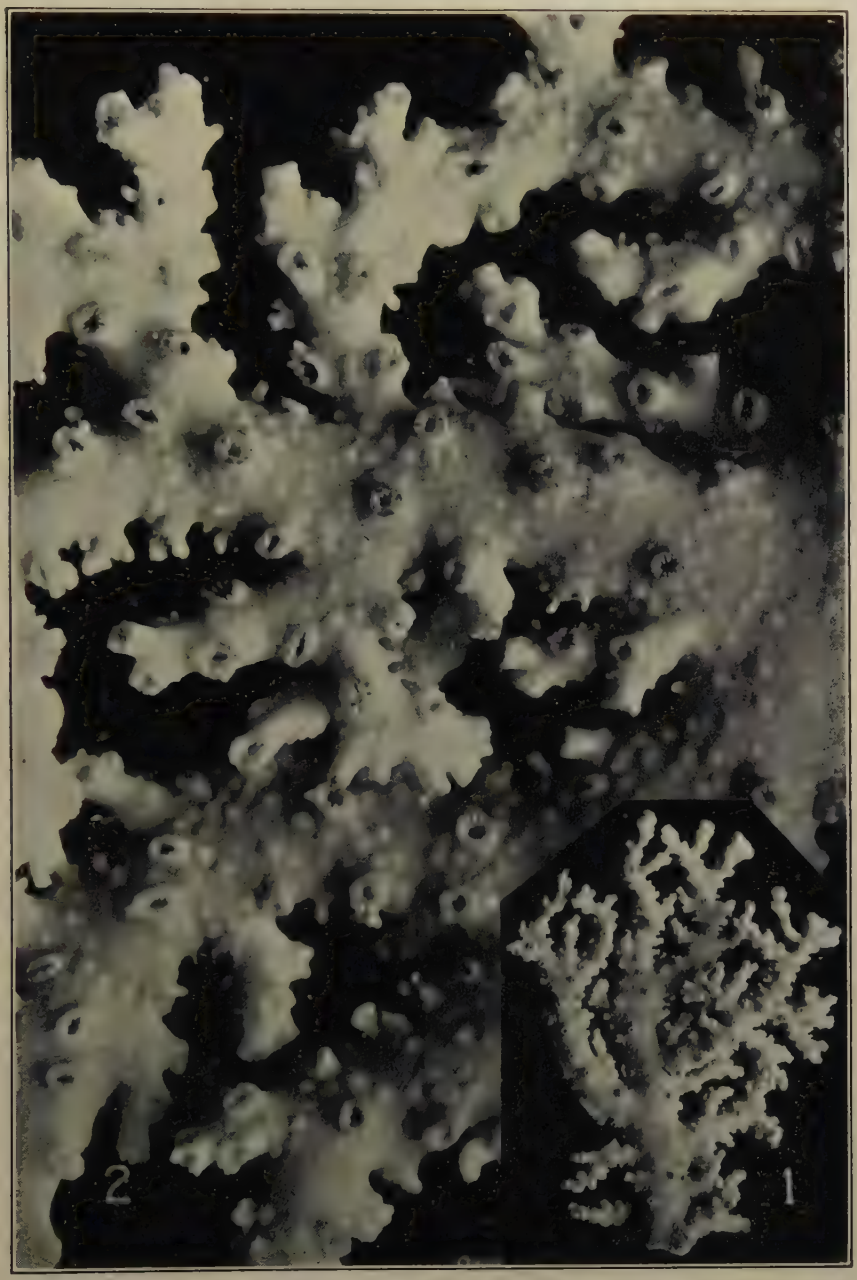

ALLOPORA CAMPYLECA TRACHYSTOMA.

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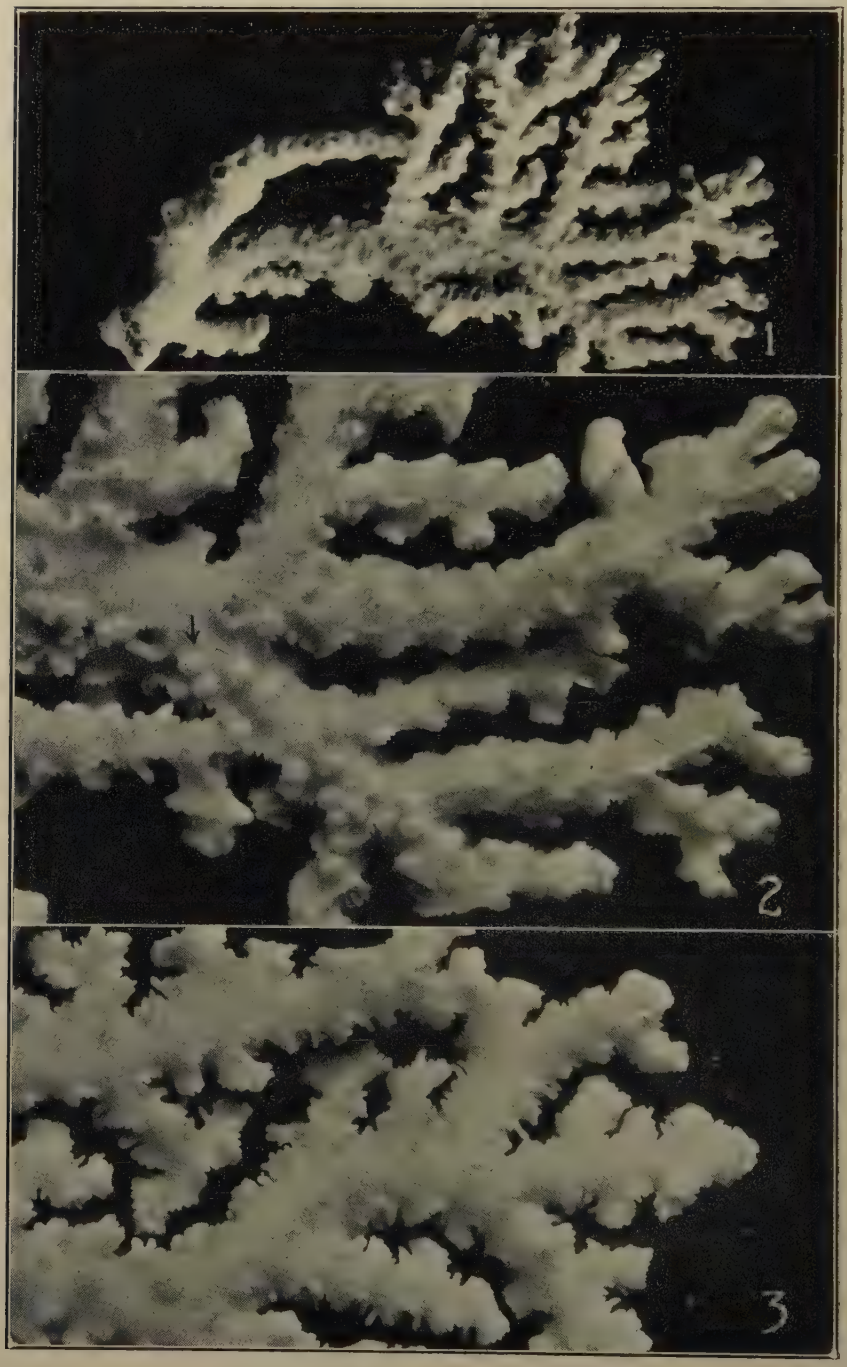

STYLASTER GEMMASCENS ALASKANUS.

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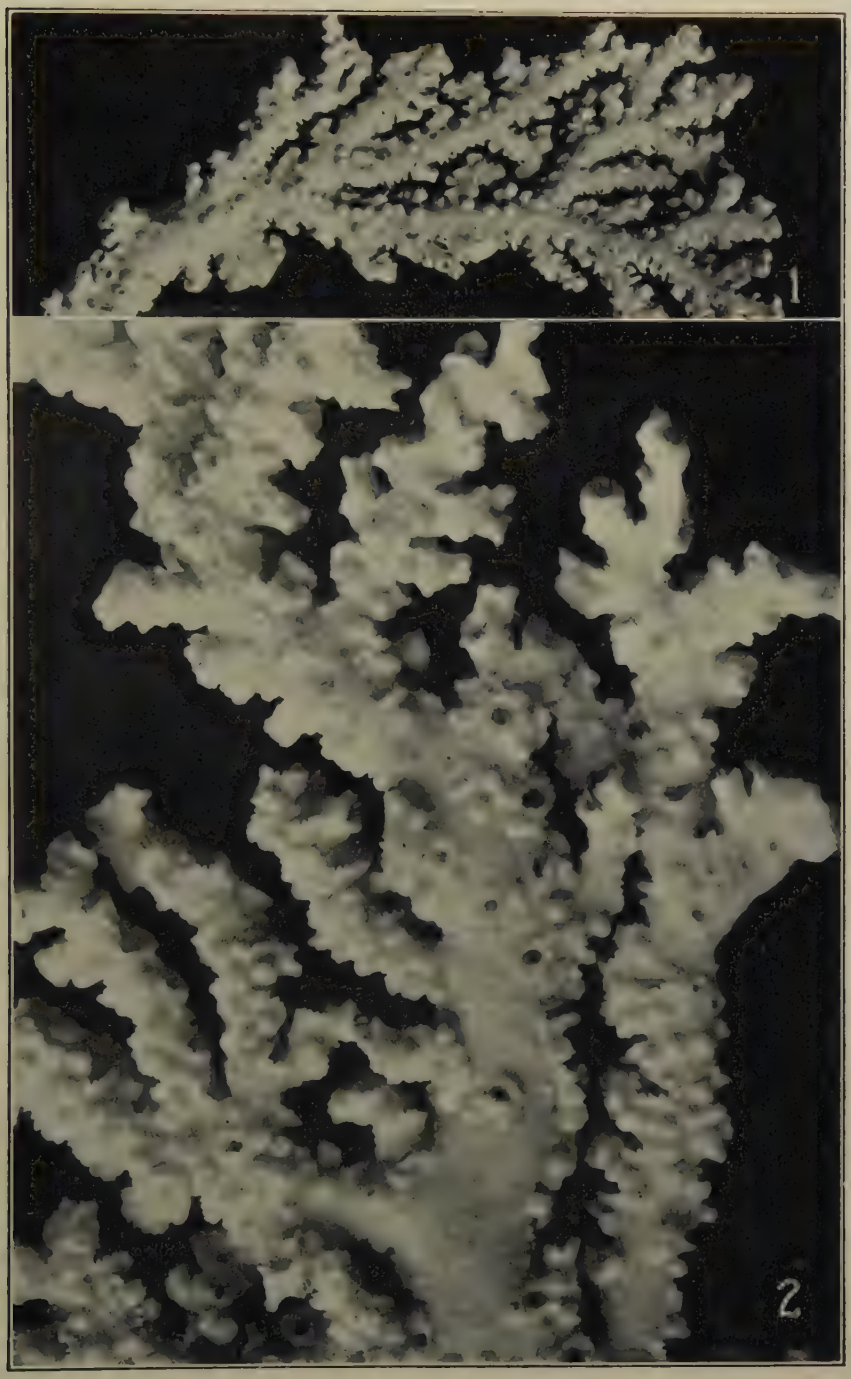

STYLASTER GEMMASCENS ALASKANUS.

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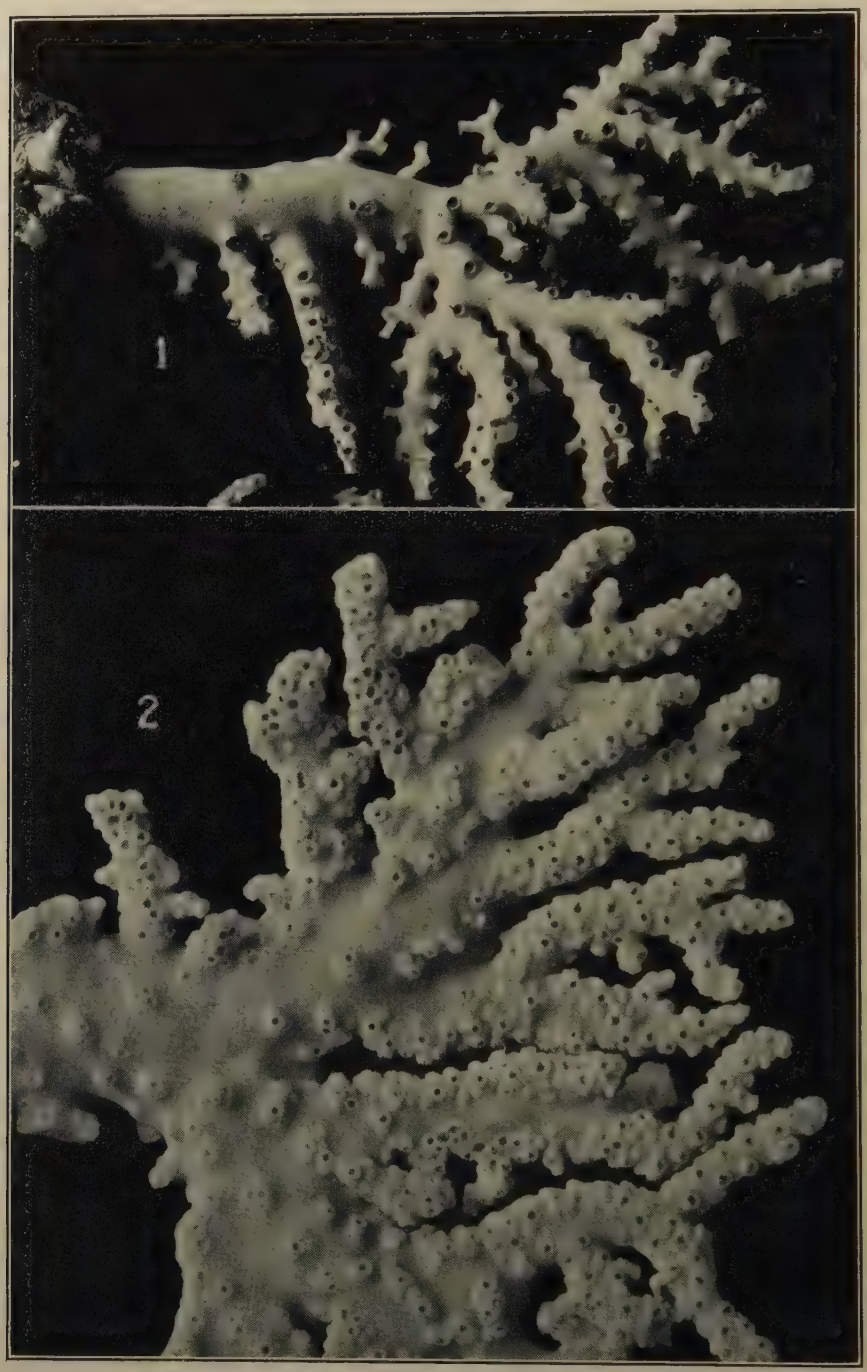

STYLASTER ELASSOTOMUS (1) AND ALLOPORA MOSELEYANA (2).

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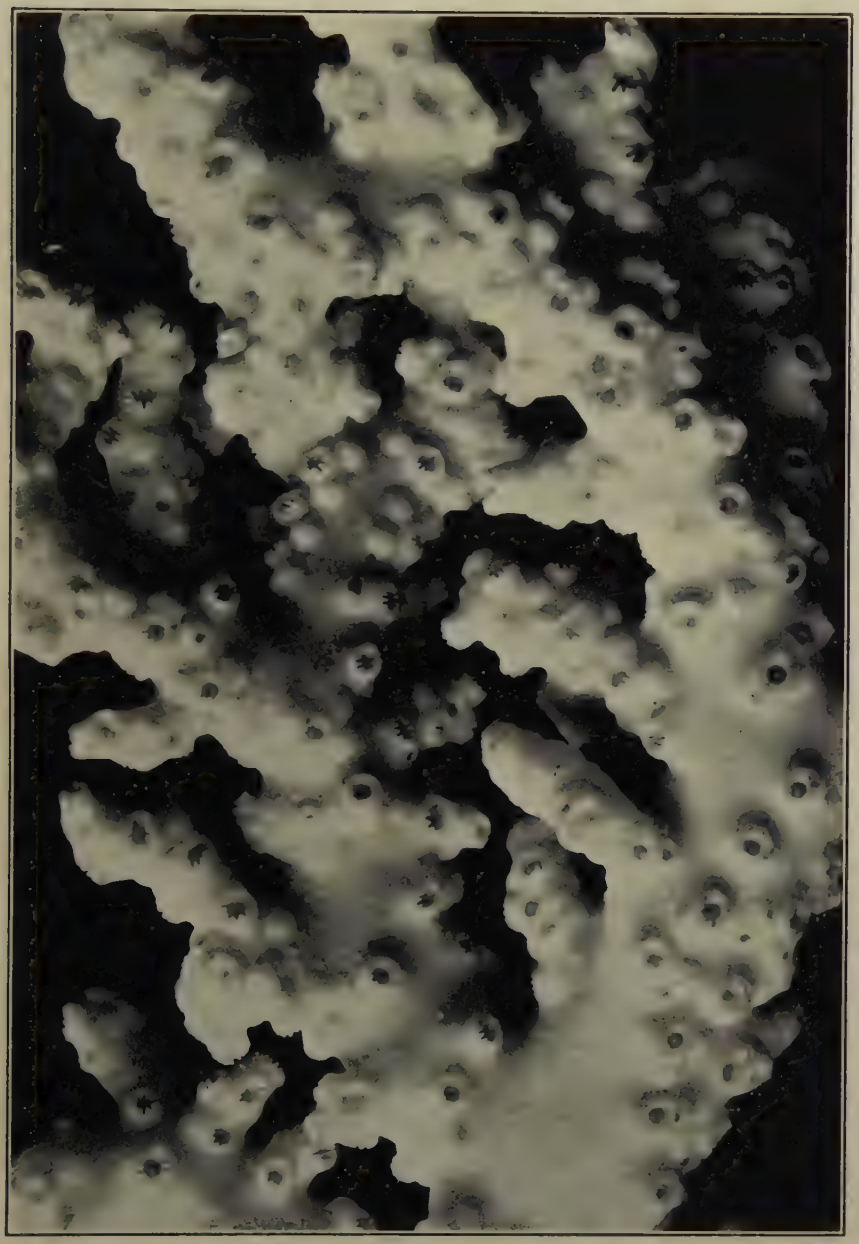

ALLOPORA MOSELEYANA.

FOR EXPLANATION OF PLATE SEE PAGE 550.

ALLOPORA MOSELEYANA.

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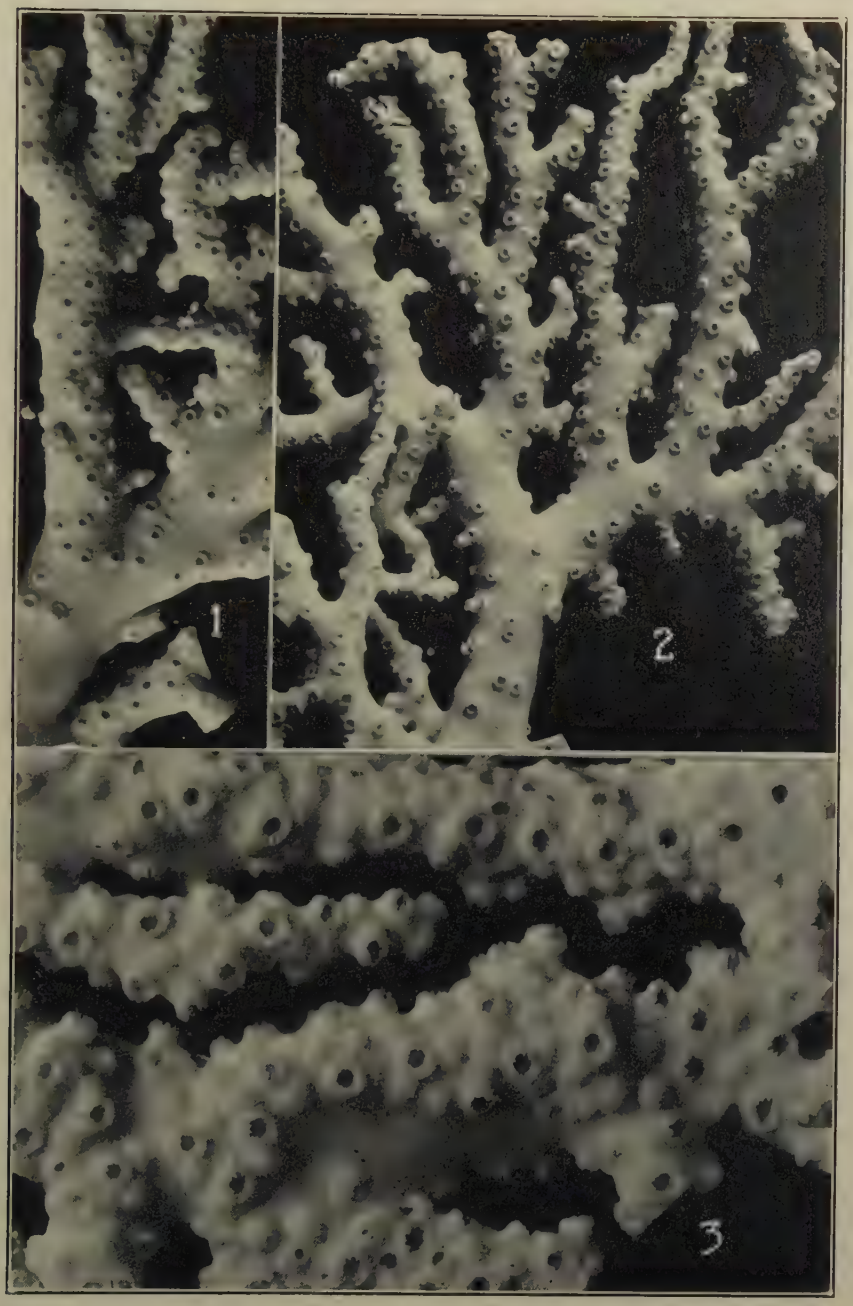
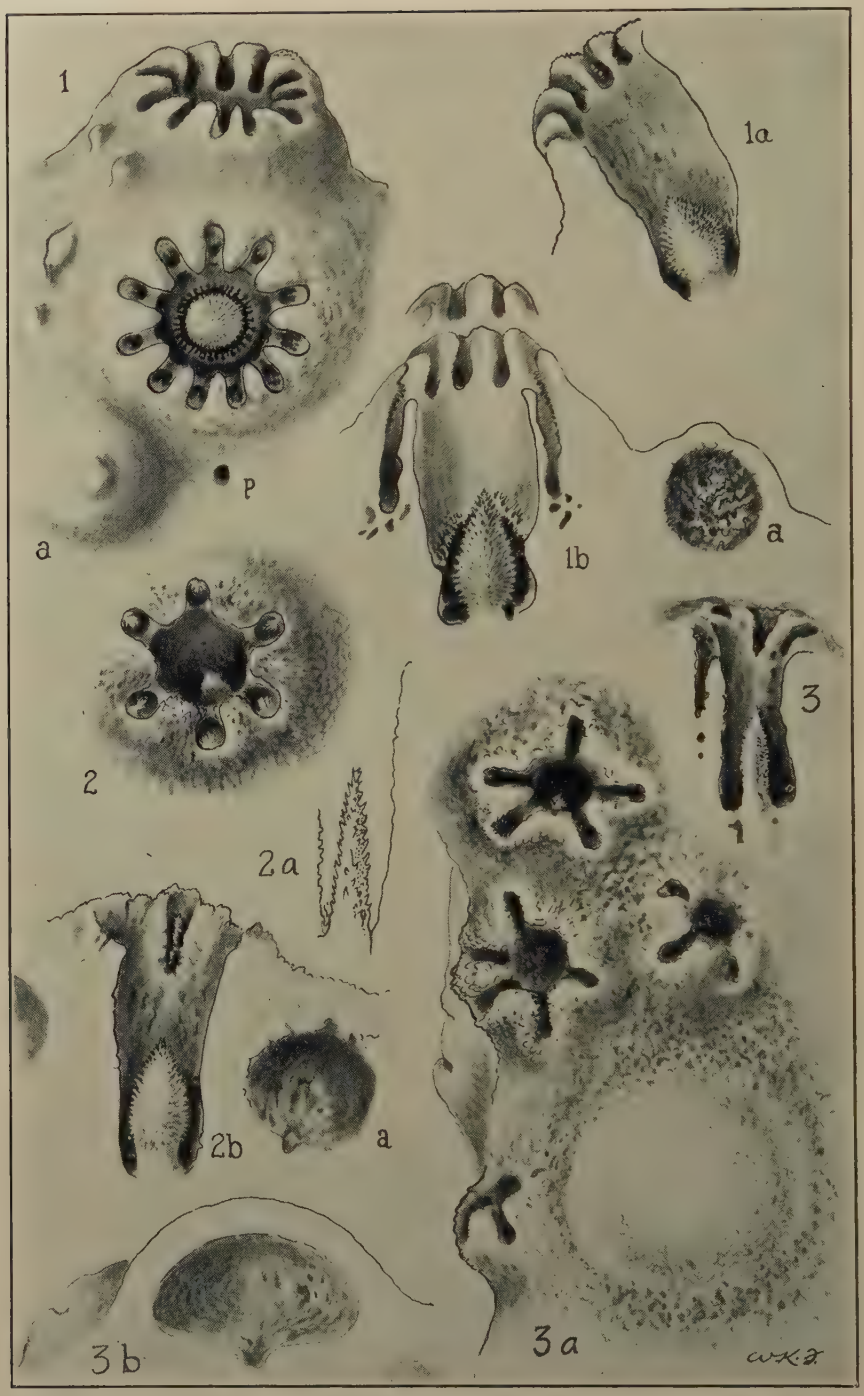


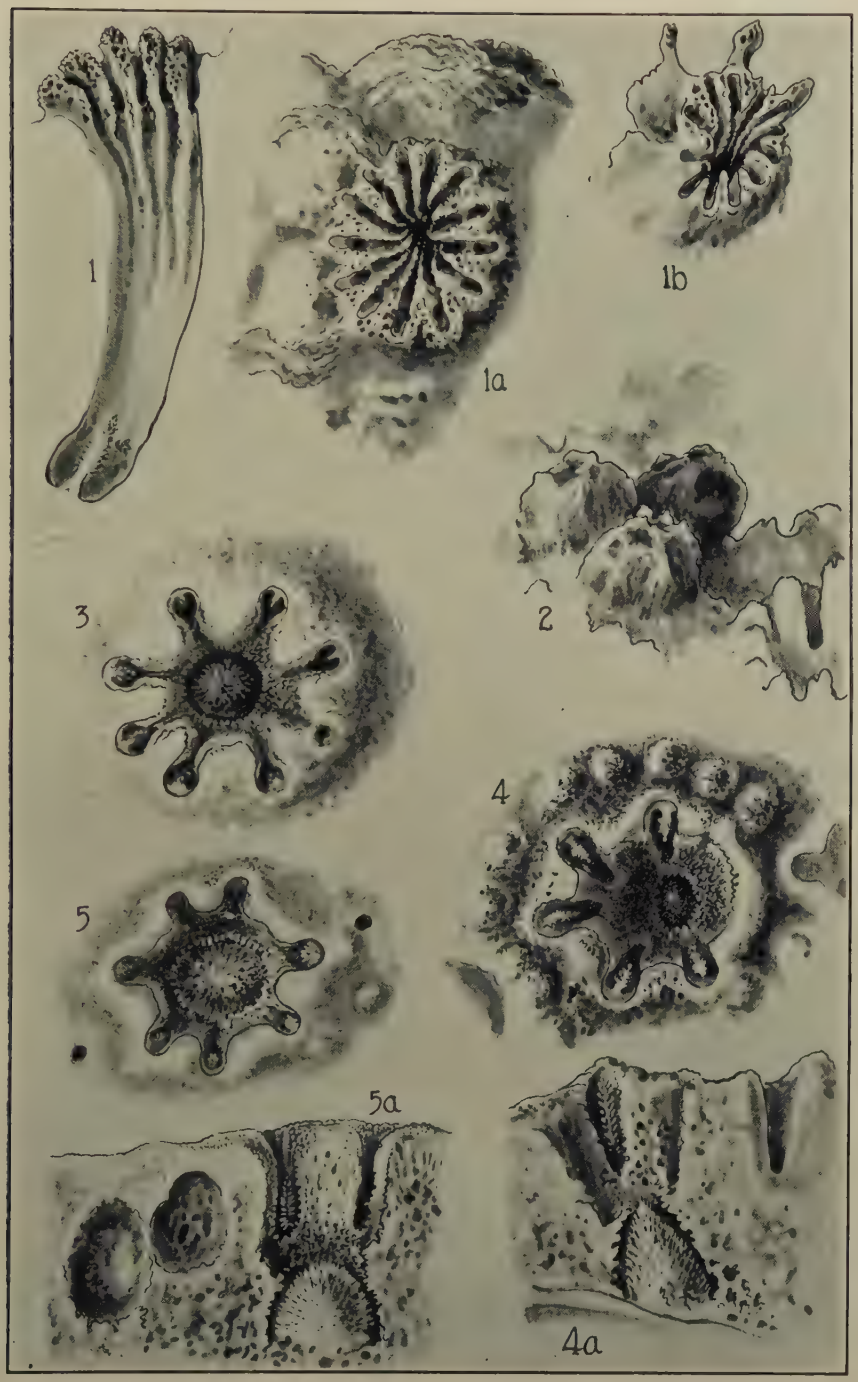
ALLOPORA MOSELEYANA FORMA LEPTOSTYLA.

FOR EXPLANATION OF PLATE SEE PAGE 550.



ALLOPORA MOSELEYANA (1), A. NORVEGICA PACIFICA (2), AND A. BOREOPACIFICA (3).

FOR EXPLANATION OF PLATE SEE PAGES 550–551.

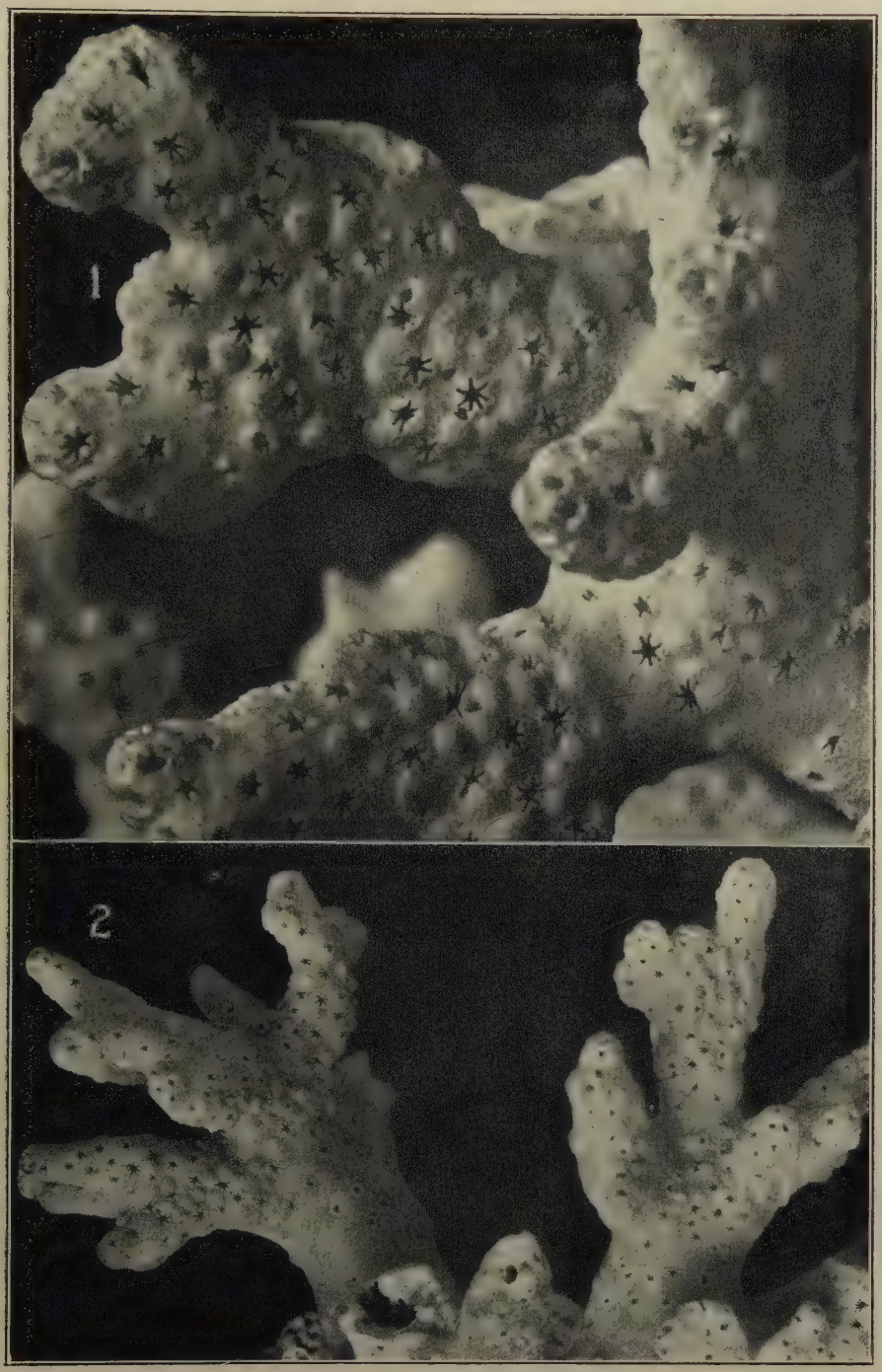


ALLOPORA CAMPYLECA TRACHYSTOMA (1), STYLASTER GEMMASCENS ALASKANUS (2), ALLOPORA VERRILLI (3), A. PAPILLOSA (4), AND A. PETROGRAPTA (5).

FOR EXPLANATION OF PLATE SEE PAGE 551

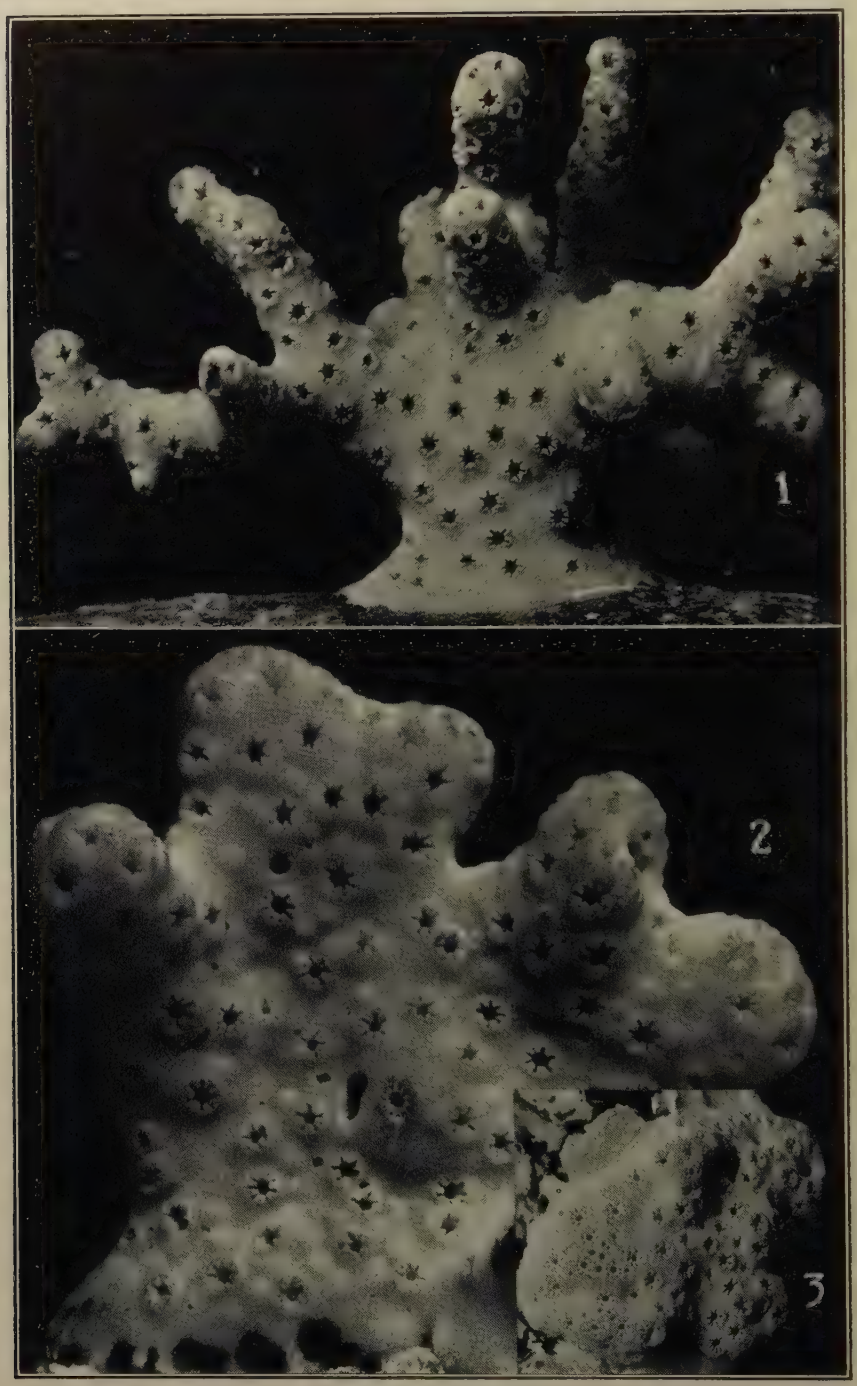
ALLOPORA NORVEGICA PACIFICA (1), A. BOREOPACIFICA (2), AND A. VENUSTA (3).

FOR EXPLANATION OF PLATE SEE PAGE 551.



ALLOPORA STEJNEGERI.

FOR EXPLANATION OF PLATE SEE PAGE 551.

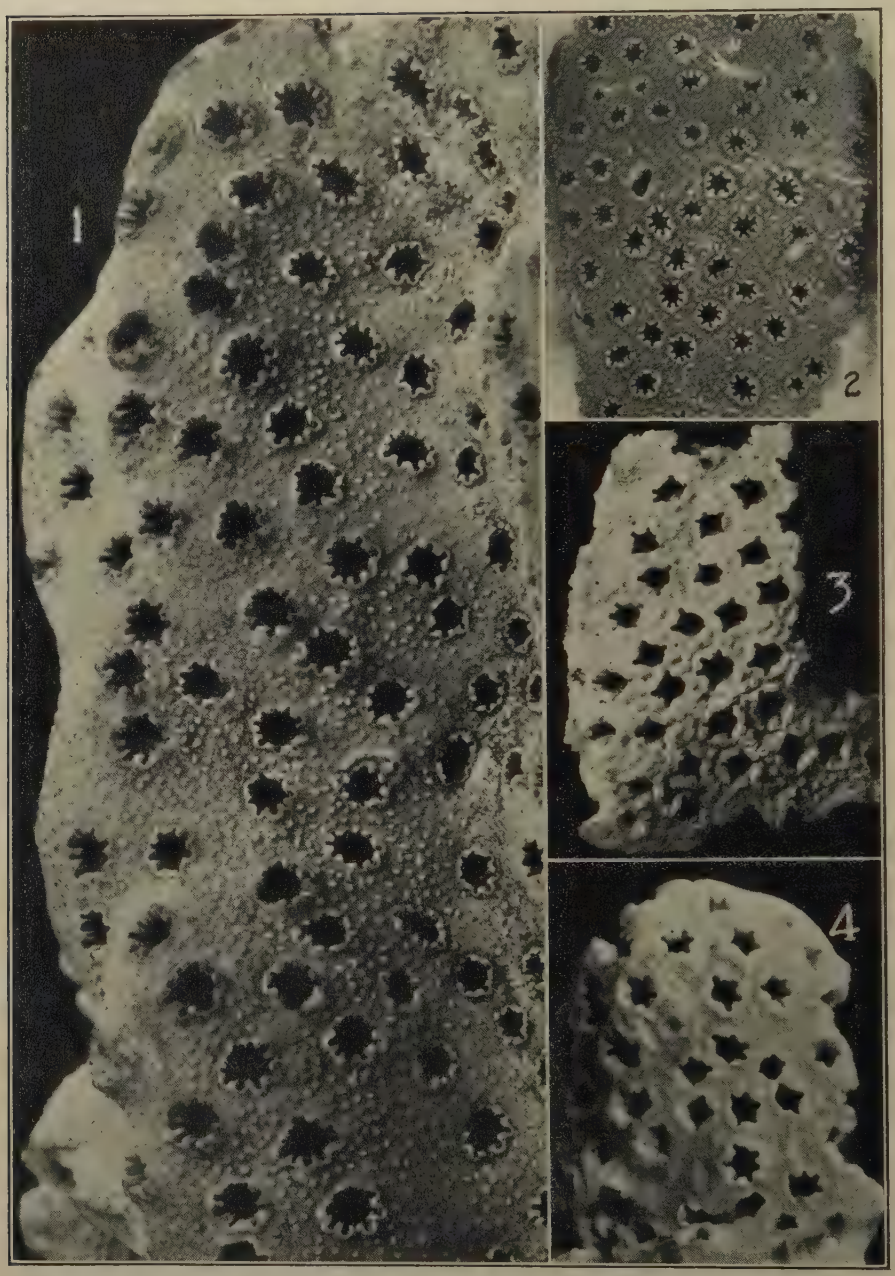


ALLOPORA VERRILLI.

FOR EXPLANATION OF PLATE SEE PAGE 551.

ALLOPORA CALIFORNICA.

FOR EXPLANATION OF PLATE SEE PAGE 551.

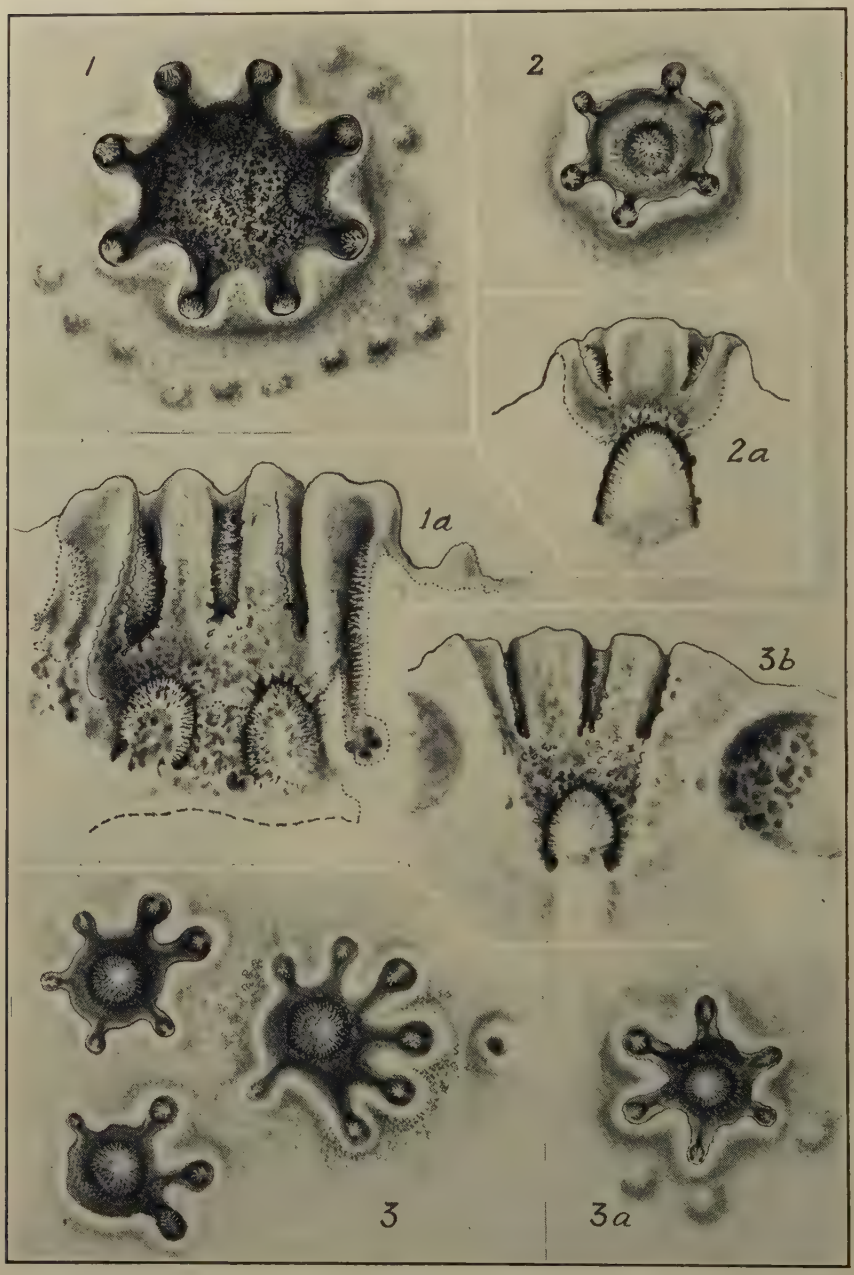


ALLOPORA PORPHYRA (1, 2), A. PAPILLOSA (3), AND A. PETROGRAPTA (4).

FOR EXPLANATION OF PLATE SEE PAGE 551.

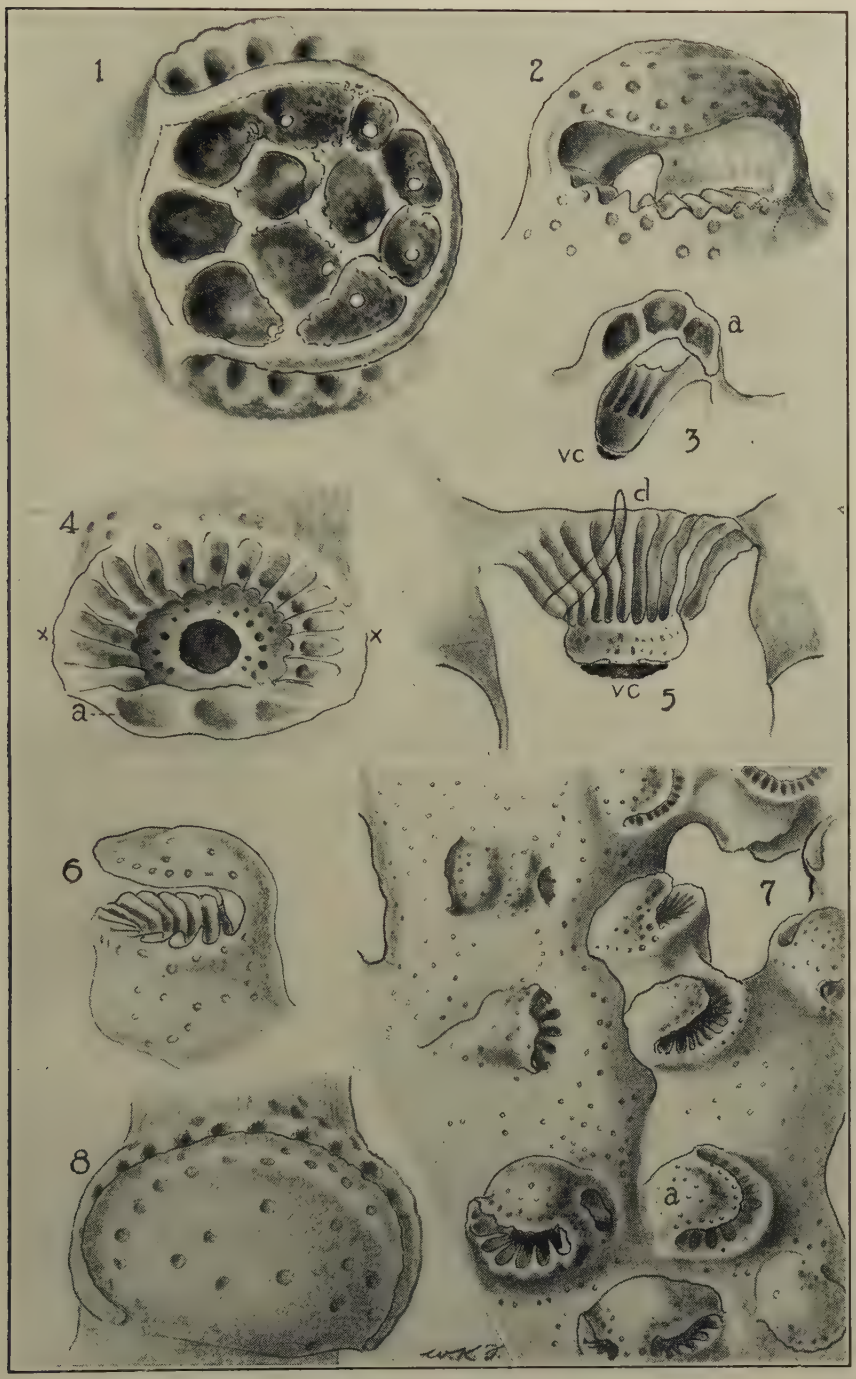
ALLOPORA PORPHYRA

FOR EXPLANATION OF PLATE SEE PAGE 552



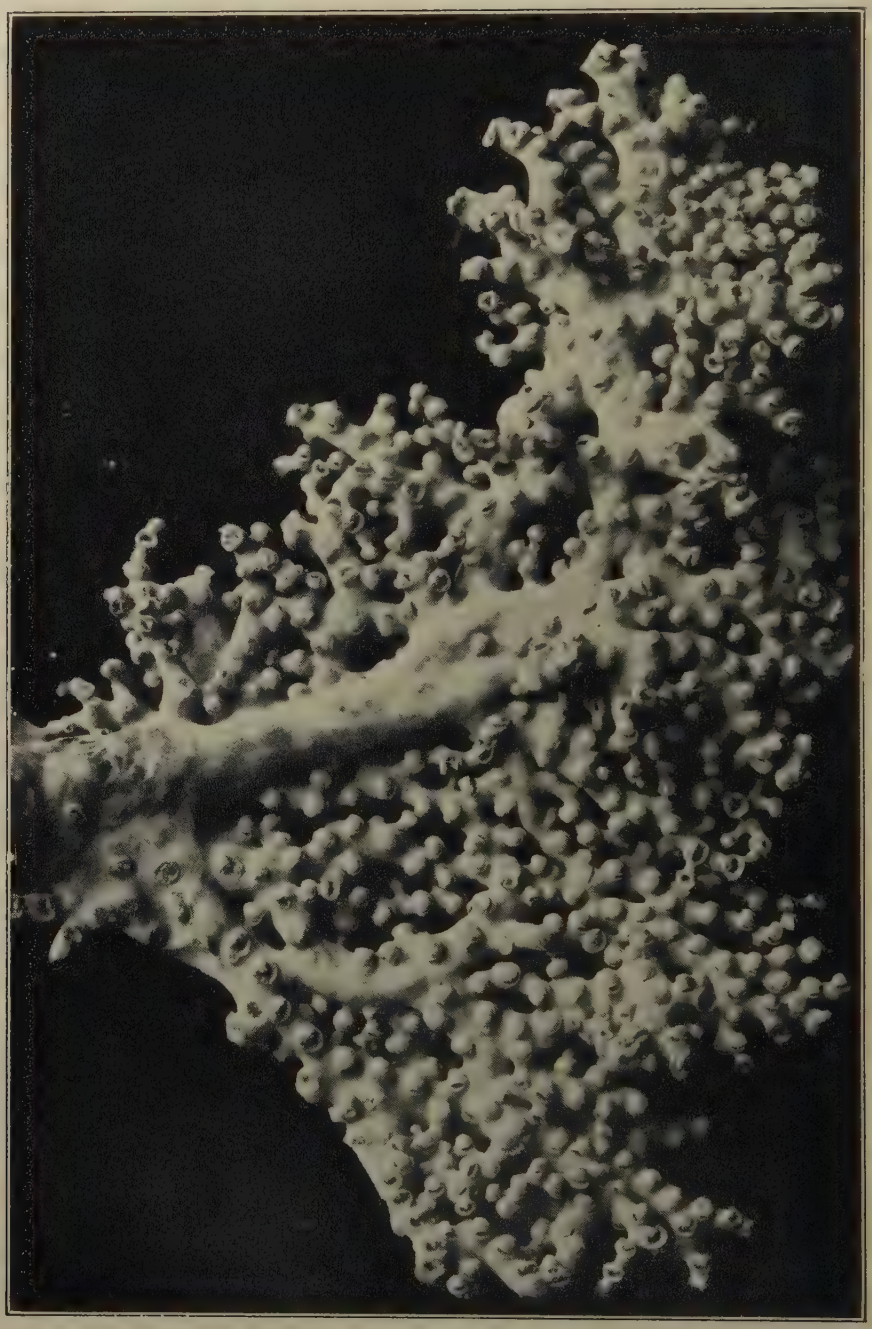
ALLOPORA PORPHYRA (1), A. VENUSTA (2), AND A. CALIFORNICA (3).

FOR EXPLANATION OF PLATE SEE PAGE 552.



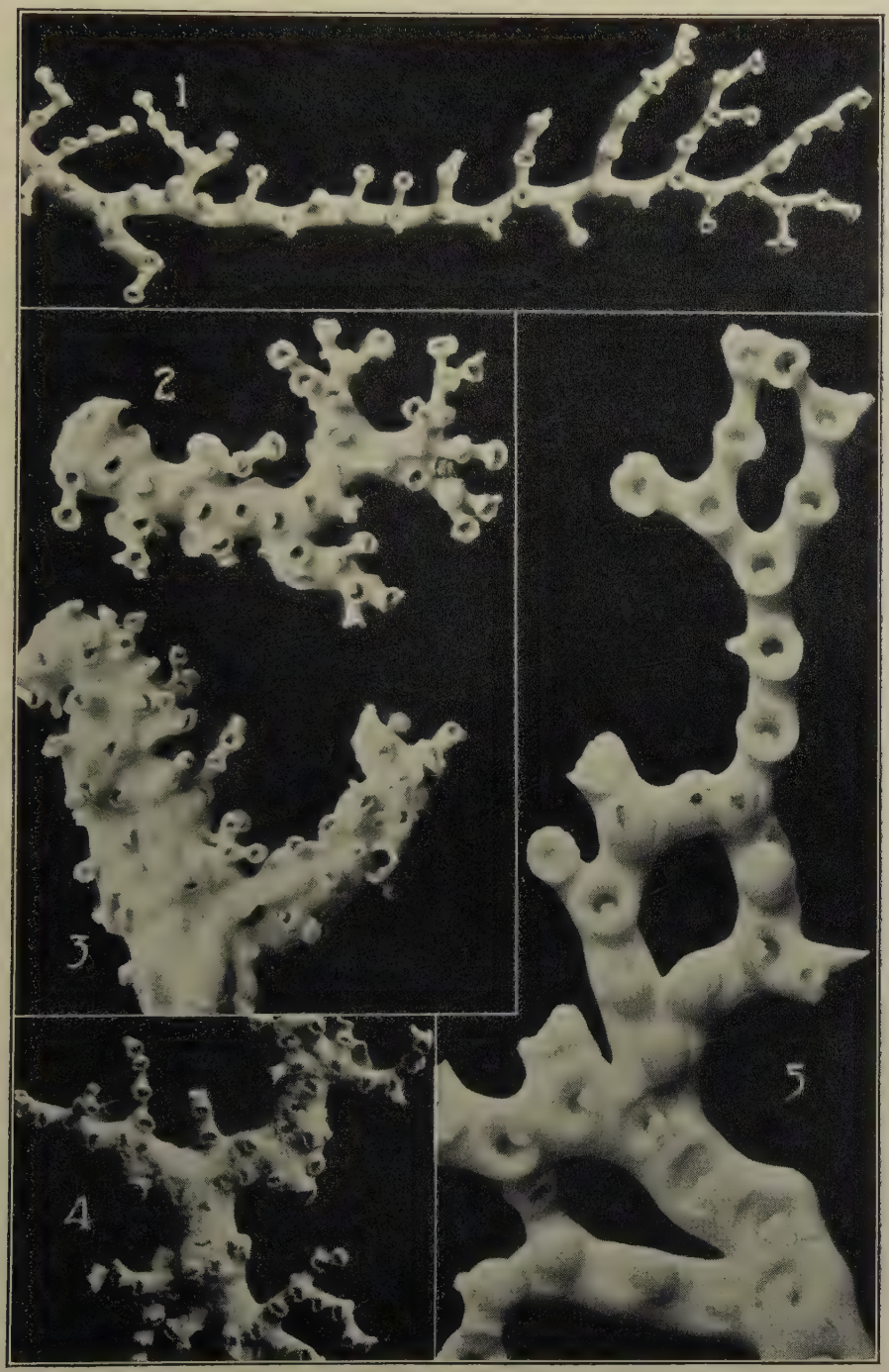
CRYPTOHELIA TROPHOSTEGA.

FOR EXPLANATION OF PLATE SEE PAGE 552.



CRYPTOHELIA TROPHOSTEGA.

FOR EXPLANATION OF PLATE SEE PAGE 552.



CRYPTOHELIA PUDICA (1), C. JAPONICA (2-4), AND C. GIGANTEA (5).

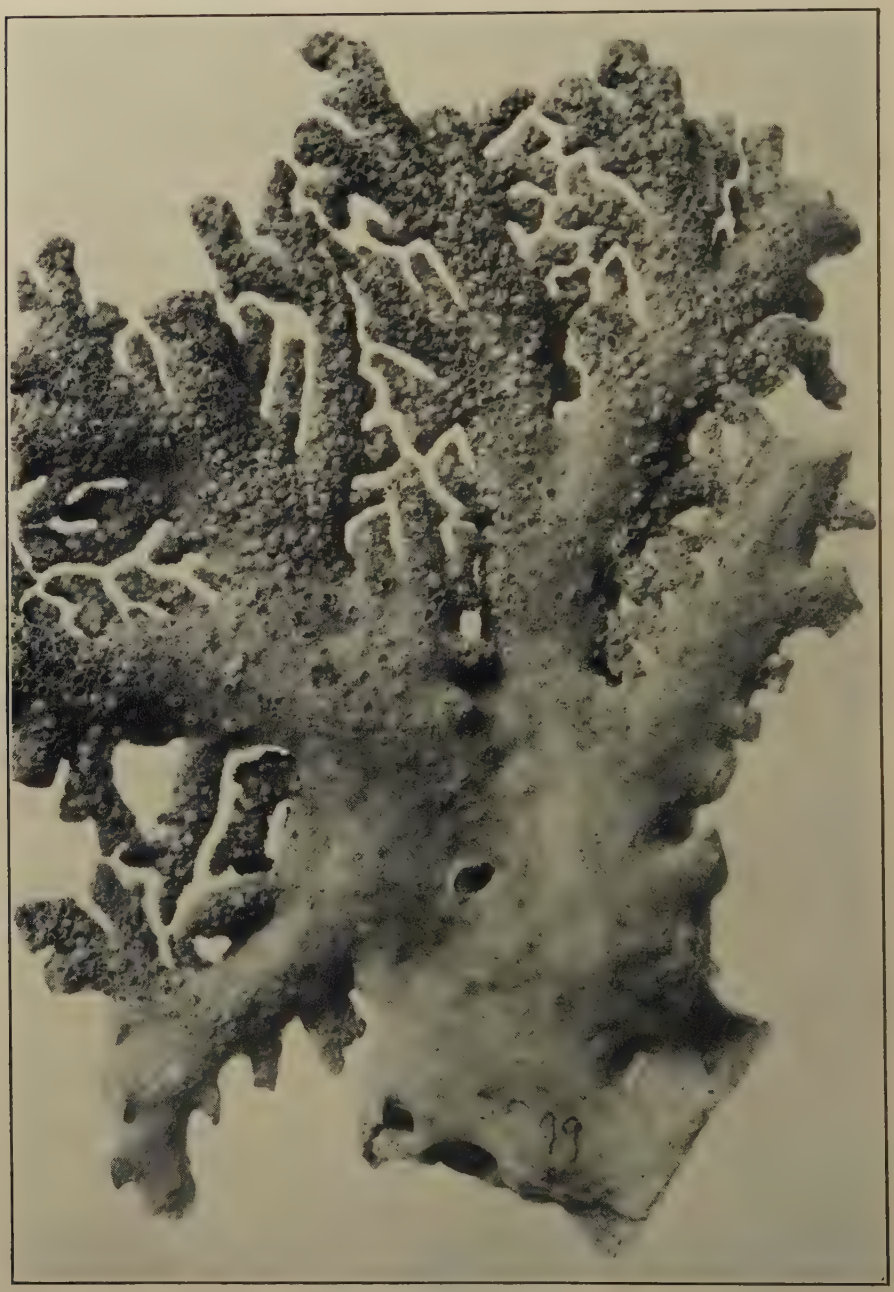
FOR EXPLANATION OF PLATE SEE PAGE 552.

ERRINOPORA STYLIFERA (1) AND E. POURTALESII (2).

FOR EXPLANATION OF PLATE SEE PAGE 553.

ERRINOPORA NANNECA (1) AND E. POURTALESII (2).

FOR EXPLANATION OF PLATE SEE PAGE 553.

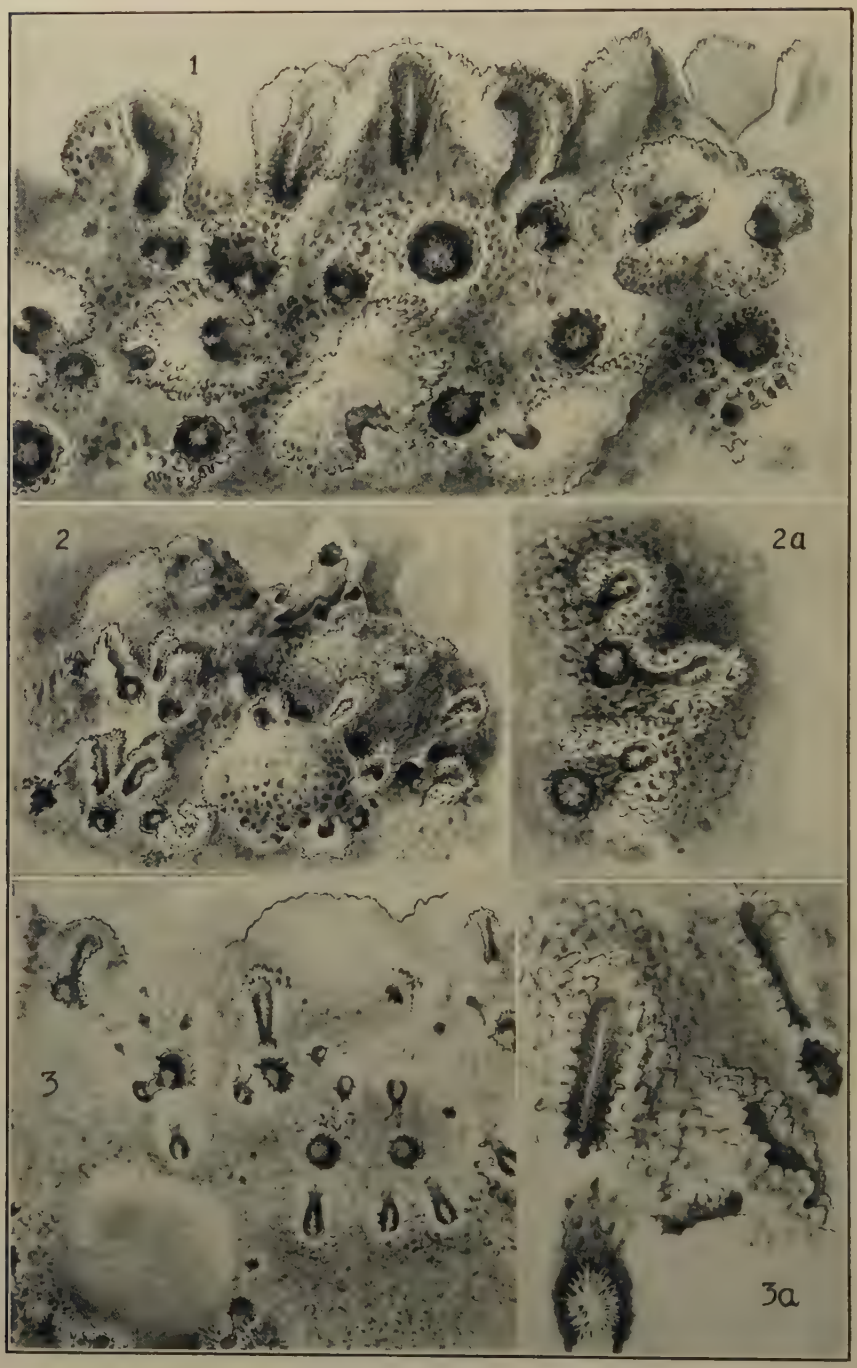


ERRINOPORA NANNECA.

FOR EXPLANATION OF PLATE SEE PAGE 553.

ERRINOPORA ZARHYNCHA.

FOR EXPLANATION OF PLATE SEE PAGE 553.



ERRINOPORA ZARHYNCHA (1), E. NANNECA (2), AND E. STYLIFERA (3).

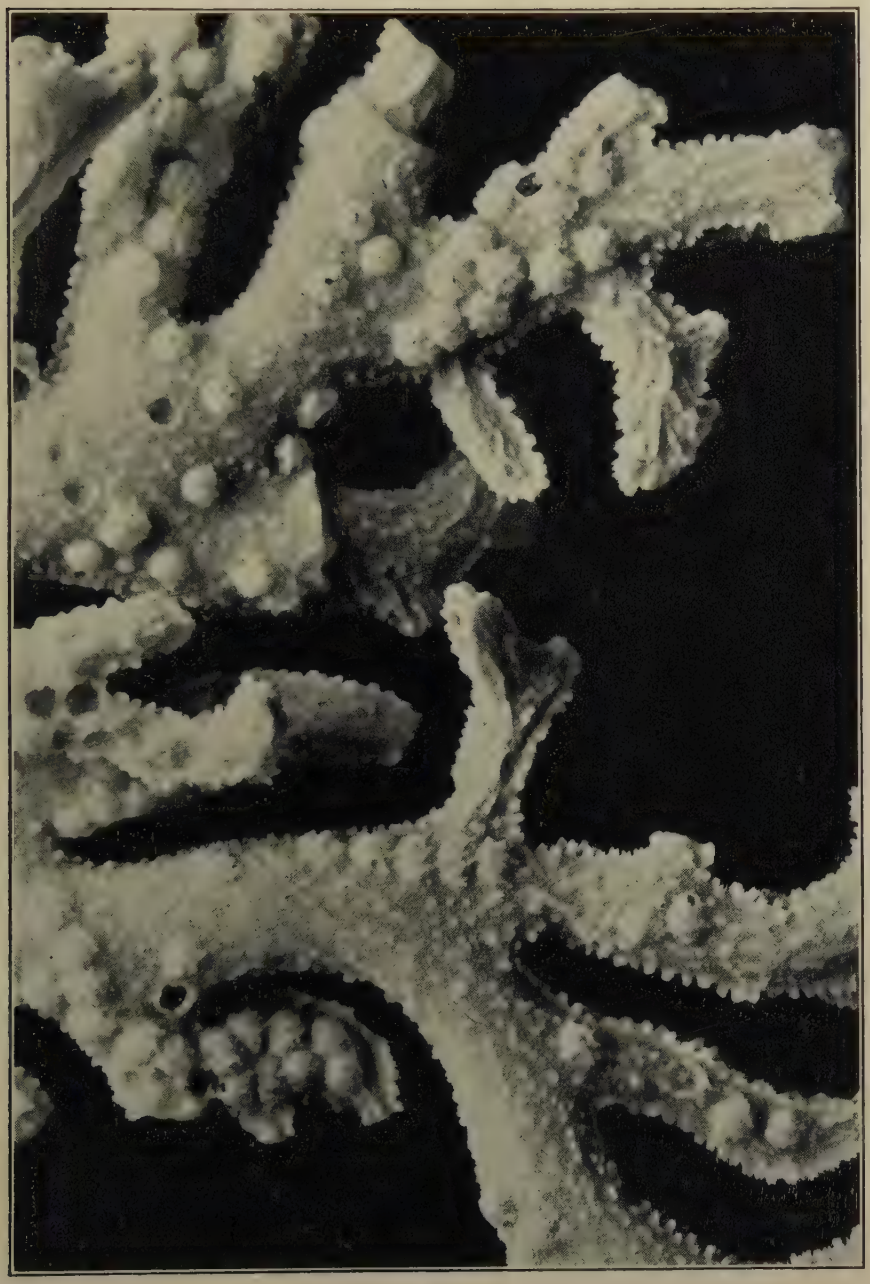
FOR EXPLANATION OF PLATE SEE PAGE 553.

ERRINOPORA POURTALESII (1), ALLOPORA PORPHYRA (2), AND DISTICHOPORA BOREALIS (3).

FOR EXPLANATION OF PLATE SEE PAGE 553.

DISTICHOPORA BOREALIS.

FOR EXPLANATION OF PLATE SEE PAGE 553.

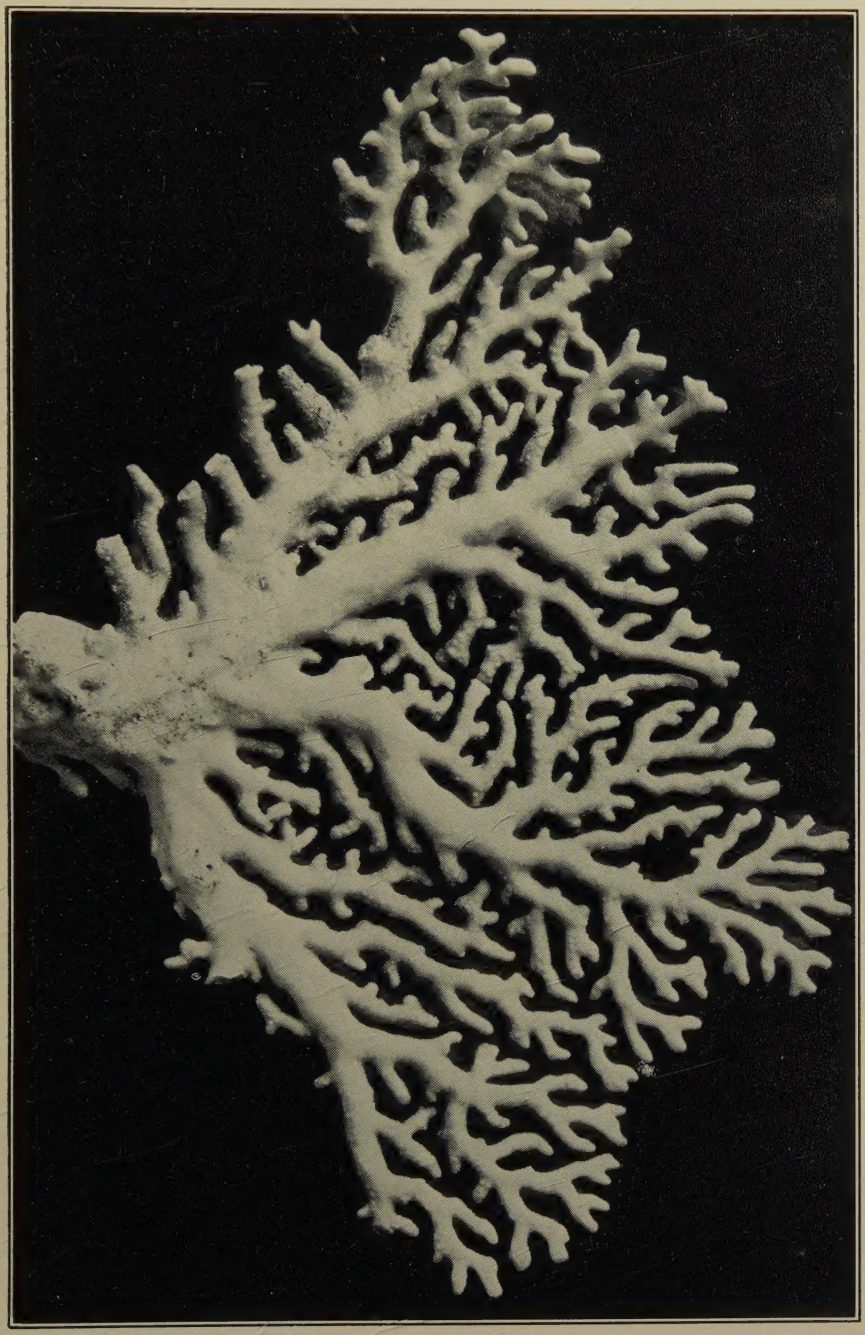


DISTICHOPORA BOREALIS.

FOR EXPLANATION OF PLATE SEE PAGE 553.

DISTICHOPORA BOREALIS.

FOR EXPLANATION OF PLATE SEE PAGE 553.

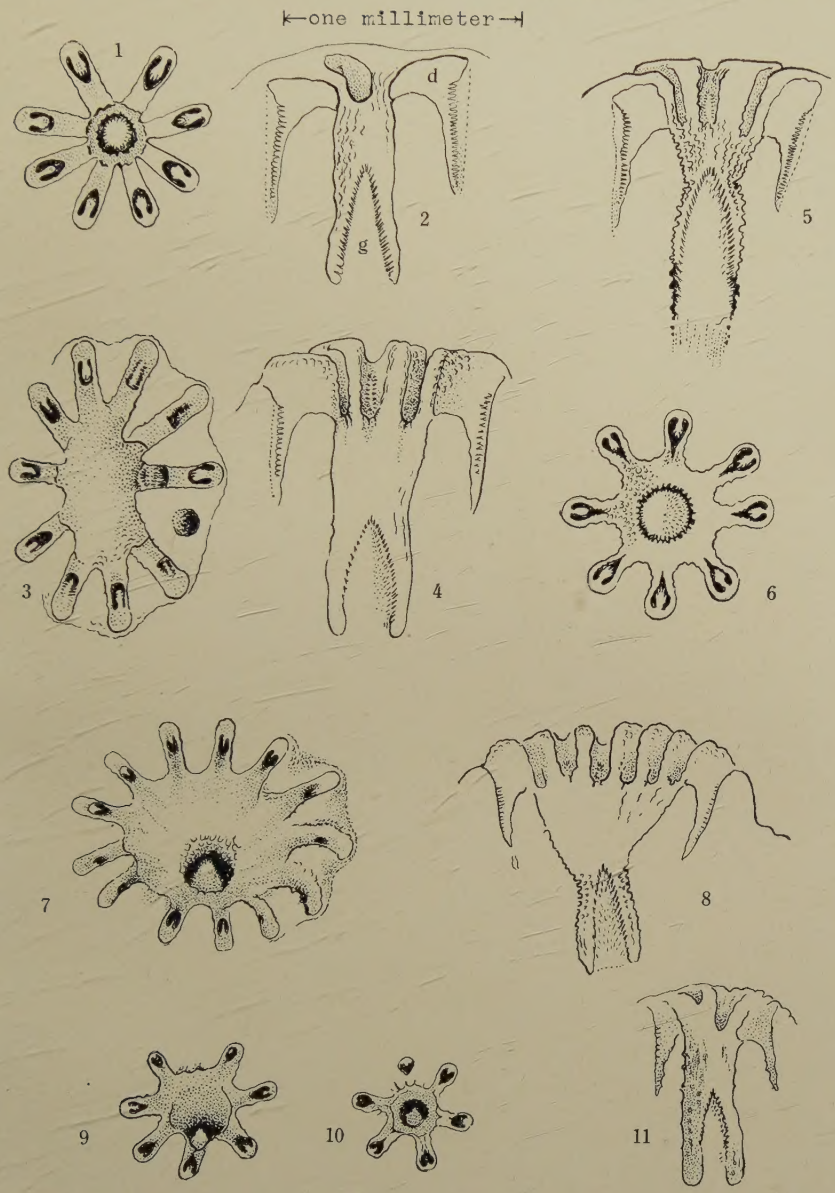


DISTICHOPORA SULCATA.

FOR EXPLANATION OF PLATE SEE PAGE 554.

DISTICHOPORA GRACILIS.

FOR EXPLANATION OF PLATE SEE PAGE 554.



ALLOPORA SOLIDA (1, 2), A. NORVEGICA PACIFICA (3, 4), A. VERRILLI (5, 6), A. SCABIOSA (7, 8), AND A. BOREOPACIFICA (9-11).

FOR EXPLANATION OF PLATE SEE PAGE 554.